A SURGICAL HANDBOOK

CAIRD & CATHCART.

STANDARD WORKS FOR STUDENTS.

By A. MACALISTER, M.D., F.R.S.,

Professor of Anatomy, University of Cambridge.

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A

SURGICAL HANDBOOK:

FOR THE USE OF

Students, Practitioners, House-Surgeons, and Dressers.

BY

FRANCIS M. CAIRD, M.B., F.R.C.S. (Ed.),

AND

CHARLES W. CATHCART, M.B., F.R.C.S. (Eng. & Ed.)

Assistant Surgeons, Royal Infirmary, Edinburgh.

With very Numerous Illustrations.

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PREFACE.

In complying with the wish of the Publishers to write the following Manual, the Authors have endeavoured to make it as practical, and as thoroughly in keeping with modern surgical methods, as possible. They hope that it may prove a convenient and ready help to those engaged in active surgical work.

The illustrations have been mainly taken from drawings from nature by W. Scott, M.B.; figures 5, 7, 8, 94, 122, 123, 129, 130, 133, are from Porter's "Surgeon's Pocket-Book," and figures 178-184 from Landois and Stirling's "Text-Book of Physiology."

Their best thanks are due to Professor Tait, who has kindly revised the chapter on Electricity, and to J. H. A. Laing, M.B., who has given valuable assistance in preparing the drawings illustrating Massage.

In conclusion, there only remains to say, that, while both Authors share the responsibility of the whole book, each has chosen certain departments. Thus, F. M. Caird has undertaken Chapters III., IV., XI., to XVII. inclusive, and XXVIII., and C. W. Cathcart the remainder.

Edinburgh,
March, 1889.

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A SURGICAL HANDBOOK.

CHAPTER I.

CASE-TAKING.

Contents.—Importance of accurate "Case-taking"—How to record a case—Outline of a systematic plan—Application.

THERE are few parts of a Medical Student's training more important than that of systematically recording the condition, treatment, and progress of patients, when under Medical or Surgical care. The scientific knowledge of disease is based on information thus acquired, and the success of the individual practitioner will greatly depend upon the skill with which he can rapidly and accurately strike upon the leading features and facts of each case, a skill which is only acquired by the careful and laborious study of *many* particular cases.

In the Hospital practice of a Medical School, therefore, the objects of case-taking are no less scientific than educational, and both of these will be kept in view, in the directions which follow.

How to Record a Case.—Descriptions of cases may be either written into a regular case-book, or they may be first taken on separate sheets of paper, and afterwards bound together. In either way, the details must be systematically indexed and entered under distinct headings such as the following :—

1. Name and Age.
2. Sex.
3. Date of Admission.
4. Disease.
5. Treatment.
6. Result, Date of Discharge or Death.

These, when filled in, stand as a brief abstract of each case, and when the page on which they are recorded is added, they serve as a useful index at the beginning or end of the series.

Outline of a Systematic Plan.—When a Student begins to take cases, he should have a Tabulated Scheme before him, as a guide to the questions which he is to ask.

This outline, being framed to suit all kinds of cases, will be too full for those in which only one organ or part of the body is affected. Still,

it is well to form a habit of systematically examining every important organ or system, and should nothing be wrong, the phrase "health otherwise good," or "other systems normal," will express what is wanted. Upon the due action of every important system depend the health of the individual, his tendency to inflammation, his power of healing, and his resistance to the influence of micro-organisms.

It is usual in hospitals to have the case-taking card on a separate slip of paper, so that it may be used conveniently at the bedside. The following scheme embraces what is generally required:—

Tabulated Scheme.

Name—Age—Occupation—Married or Single—Postal Addres—Date of Admission—Surgeon in Charge—No. of Ward—Complain of.

General Description of Patient—In a few pointed words.

Previous Health.—General sketch.

Social History and Occupation.—Mode of life—Habits as to alcohol, tobacco, and diet.

Respiratory System.—Indications of bronchitis, tuberculosis, or pneumonia.

Circulatory System.—Condition of heart and vessels.

Digestive System.—Condition of tongue and mouth, appetite and digestion—Evacuations.

Skin.—Perspiration—Evidences of present or past diseases—Temperature in axilla.

Nervous System.

Genito-Urinary System.—Micturition—Condition of urine—(If female, catamenia, number of children, and of miscarriages).

Condition on Admission.—State of shock (from an eye-witness, if an injury)—Describe affected part (1) On inspection; (2) On palpation; (3) By patient's sensations—Sketch or photograph of part.

History of Present Disease or Injury.—Mode of onset—Supposed cause—Progress.

Diagnosis and Remarks by Surgeon.

Treatment.—Operation to be merely mentioned if of usual kind, otherwise to be fully described—The anæsthetic specified (if any is given), and patient's behaviour under it—Amount and condition of parts removed—Nature of dressing.

Progress.—Notes are to be made at least twice a week, more frequently, if case be serious.

Termination.—If death; its cause, and results of *post-mortem* examination—If discharged from hospital, the condition is to be stated.

Application of the Above.—It is to be understood that these headings need not be repeated before each part of the case. The sex may be stated when the name does not indicate it, otherwise omitted. The first paragraph might, therefore, run as follows:—

"John Thomson, aged 27, married, a miner, residing at 6 Pithead Cottages, Wishaw, was admitted on March 4th, 1886, to Ward 5, Royal Infirmary, under Mr. Cutter's care, suffering from 'a lump in the right hip.'"

The general description which follows, should be as terse and expressive as possible—*e.g.*, "a well-built man, somewhat careworn and emaciated."

The object of the notes as to Previous Health, is to try to throw light on the present condition, or on the progress of the case. Thus—"Until a year ago, when he met with an accident, by a bank of earth falling upon him, the patient enjoyed excellent health."

Similarly with the other points. Thus—"The pit in which he has worked has been frequently flooded within the last year, and the workmen have all suffered considerably from the wet and damp. Owing to strikes, he has been thrown a good deal out of work during the last six months, and his diet has been much restricted in consequence. He has been always moderate in his use of alcohol and tobacco.

"The Respiratory System is normal.

"The Heart Sounds are feeble, and the patient anæmic, but no other abnormality of the circulatory system is to be noted.

"The patient's Tongue is pale and flabby, Appetite and Digestion impaired, a tendency to constipation.

"The Skin and the Genito-Urinary System are quite healthy, and, except for considerable mental depression, the Nervous System seems normal also."

It is very important to note the general appearance of the patient when admitted—*e.g.*, "brought in pale and motionless on a shutter, having lost much blood;" or, "flushed, restless, and excitable;" or, as in the present case—

"The patient had to be supported in walking into the waiting-room, and was evidently suffering considerable pain."

In describing the affected part, it is a good rule to learn as much as possible by inspection before handling the part; the position of the patient, attitude of the limb, discoloration, apparent swelling, or pulsation, &c., can thus receive due attention, and this will help the after-examination to be more thorough. By "palpation" is made out the consistence, relations, and connections of surrounding parts, relative temperature of skin, nature of pulsation, or the state of adhesions. Under the head "of patient's sensations" are included all the information that depends on the patient's own description—subjective symptoms, pain, throbbing, &c.—a good deal of which will probably have been made out in the previous examination. The case would then run thus—

"The patient being unable to straighten his right leg, bent his body forward when standing, and leant chiefly on the opposite side; when seated, his weight was borne on the sound side. A considerable swelling was seen below the front of the crest of the ilium, extending down the thigh, but the skin was not discoloured nor altered. When the fascia lata was relaxed, fluctuation was easily felt over nearly the whole

of the swollen area. The patient complained of only an uneasiness when he lay quiet in bed, but any attempt at walking brought on considerable pain."

In the **History** of the existing disease or injury, is to be included every particular up to the date of entry into hospital—relapses, previous operations, or other treatment, rapidity and advance of symptoms, acuteness of pain, &c.—as upon this the diagnosis often depends. There should be noted also, if possible, the exact way in which an injury was inflicted, the position of the patient at the time, and direction of the blow, or nature of the twist.

Under the head of **Diagnosis**, it is well to include, when necessary, the examination of fluids withdrawn, or small parts cut off, for diagnostic purposes, as well as the *possible* diagnoses when the surgeon is uncertain, and any other remarks made.

The **Treatment**, of course, includes regimen, diet, and the nature of the apparatus used, as well as of all operative treatment employed. The operator will usually indicate the details which he wishes to have recorded. For future reference, a full description of the amount of tissue or fluid removed, and its condition, should be noticed and often sketched, and the result of microscopic examination, when this has been thought necessary, should be added.

The **Antiseptic** precautions during and after any operation should be noted, together with the position of the drainage-tubes, the sutures, and the mode of dressing.

It is also well to have graphic **Temperature-charts**, on which the morning- and evening-temperatures are set down, as well as the state of the pulse, and condition of the bowels. On these may be stated also the diet, medicinal and other treatment, and a brief record of any noteworthy change in the patient's condition. In bad cases, the temperatures and other details may be recorded every two hours or oftener; in others, when the progress is more uniform, once or twice a week is all that is necessary.

Besides filling up the details of the **Termination**, as indicated above, it is very important, where possible, to trace the history of patients after leaving the hospital. For this purpose, when they come back to report themselves (as they often do), a note should be added to their case, and any change in their originally-noted postal address should be inserted in the proper place.

CHAPTER II.

ON THE TREATMENT OF PATIENTS BEFORE AND AFTER OPERATION.

Contents.—I. Treatment before Operation—Constitutional, Local, Special—Success of operation greatly dependent on state of patient's "general health." **II. Treatment after Operation**—Constitutional, Local, Special—(*a.*) After operations about the Rectum and Anus, on the Genito-Urinary Tract, after Ovariotomy, &c.; (*b.*) after operations about the Mouth and Jaws—Difficulties in administering food: how to meet them—Nutrient enemata—General hints on nourishment.

IT would be difficult to over-estimate the importance of this subject. For convenience, we may consider it under the heads of Constitutional, Local, and Special Treatment, before operations, and after them.

I. Before Operations.—(1) *Constitutional Treatment.*—It has long been recognised that the result of operations much depends on the patient's general health, and this may be paraphrased into *the efficiency of all the organs under the conditions which follow the operation.* To secure this, some preliminary treatment may often be called for, either (1) to regulate some system or organ, and improve the blood; or, (2) to accustom the patient to the fixture and surroundings which must follow the operation.

In many patients a special diet, rest in bed, or particular drugs, may be required to improve digestion, stimulate elimination, relieve congested liver or kidneys, regulate the action of the heart, or improve nutrition. For instance, persons who regularly overload their system with an excess of alcohol, keep up the appearance of health for a long time if they are able to take active exercise. Should they be suddenly laid up, however, from a fractured limb or other cause, their health at once gives way. Symptoms of delirium tremens appear, and wounds are exceedingly apt to develop erysipelas or other septic conditions. In such cases, preliminary treatment by sparing diet, and diminished allowance of alcohol, laxatives, and rest in bed, would go far to lessen these unfortunate tendencies. In other cases, tonics, iron, and cod-liver oil may be required, and so on.

Where cases are not systematically taken, the heart and lungs should be examined, and the digestive system enquired into, the morning and evening temperature ascertained, and the urine tested. It is better to have this examination of the heart made while the patient is resting quietly in the ward, rather than add to his alarm by sounding the heart, just before the anæsthetic is given.

The **bowels** should be well opened the day before an operation, and no food should be allowed for at least four hours before anæsthetics are administered. In females, no operation should be undertaken during, or immediately before, the menstrual period.

(2) *Local Treatment.*—The area of skin which may be covered by dressings should be thoroughly cleansed with soap and water, and afterwards also with turpentine, or with washing-soda, and all hairy parts shaved. Afterwards, a towel soaked in 1-20 carbolic lotion, or 1-2000 corrosive lotion, should be applied, and covered with a mackintosh. These proceedings should be carried out, if possible, the night before any operation.

(3) *Special Treatment.*—For operations about the **face** in men, the directions regarding shaving are especially necessary, as it is a troublesome delay for the surgeon to have this to do before he can begin the operation itself.

In operations on the **bladder**, **rectum**, and **perinæum**, besides the previous opening medicine, the lower bowel should be cleared out by an enema, a few hours before the operation. Although this is the nurse's duty, the House-Surgeon must see that it is done.

There are many cases where necessity precludes any preliminary treatment, except, perhaps, a hurried cleansing with washing-soda or turpentine, and a nail-brush, to prepare for the more effective acting of the antiseptic lotion. The best that is possible under the circumstances must, of course, be the rule.

Where plastic operations involving the **transplanting of skin-flaps** by stages from distant parts are to be undertaken, the parts which are to be held in apposition must be fixed in their place for a week or ten days before, so that the patient may be accustomed to the constraint.

II. After **Operation.** — (1) *Constitutional Treatment.*—After any capital operation the patient is usually kept on milk-diet for a few days until the effects of the anæsthetic have passed off. When patients complain of much pain, the best analgesic is opium, given as morphia, hypodermically or by the mouth. The amount of the dose will vary with the patient's tolerance of the drug; but it is best to begin with small doses—say, ⅙ of a grain, which may be repeated if necessary. Children, aged people, and those with renal disease or bronchitis, bear opium badly. In sleeplessness, where there is no pain, bromide of ammonium, chloral, and hyoscyamus, prove useful.

As soon as digestion permits of it, fish or chicken is added to the diet, and, as soon as possible, full hospital diet is ordered. If the bowels do not act of themselves, they should be opened on the third or fourth day by an enema or simple laxative. The tongue, as indicative of the state of the digestive system, should be looked at from time to time. The late Mr. Syme's favourite remedy in liver and stomach derangements was powders of rhubarb (grs. v.) and soda (grs. v.) given once or twice daily before meals for a few days; to this bismuth may sometimes be added with advan-

tage. Where the liver seems sluggish, a bitter infusion, with dilute mineral acid and tincture of nux vomica, is useful. Iron is often indicated by the anæmic state of the patient, and other remedies may be required according to circumstances.

(2) *Local Treatment.* — The local treatment involves wound-dressings, which are elsewhere considered (p. 21).

(3) *Special Treatment.*—(*a.*) *In all cases of operation about the* **anus** *and* **rectum**, such as for fissure, fistula in ano, or piles, the bowels should remain unopened for about two days, and be opened on the third morning by castor oil or other mild aperient. The free opening of the bowels before the operation, and the low diet after it, generally suffice to keep the bowels from moving of themselves for some days. When morphia suppositories have been given to soothe pain after the operation, the bowels will be still more bound. It is better not to wait until the bowels move of themselves, because by that time firm fæcal masses will have formed, which would be more irritating to the recent wound than the earlier passage of a liquid stool. An enema is necessarily contra-indicated.

It should be remembered that operations upon the anus, and in its neighbourhood, are apt to cause retention of urine by reflex spasm of the constrictor urethræ. Some surgeons on this account pass a catheter at the end of the operation, and in any case provision must be made for drawing off the water within eight hours of that time, and for repeating the proceeding if need be.

(*b.*) The treatment of the **bowels** after the relief o a **strangulated hernia**, whether by taxis or by operation, is a matter of dispute. Some surgeons freely administer opium or morphia, and keep the patient on low diet, to prevent any motion of the bowels for a week or ten days. This is done to ensure rest for the injured and probably inflamed bowel, and in some cases may be necessary. Other surgeons act on the principle that if the bowel be inflamed, its peristalsis will be thereby checked, so that unless local pain or general restlessness call for the use of opium, it may be omitted and the action of the bowels left to nature. The latter seems the more rational plan, and is the one which we would advocate.

Where it is known that the bowel itself is injured, efforts will, of course, be made to ensure absolute quiet for the injured part, opium or morphia continued for a week or ten days, and the patient fed by nutrient enemata, supplemented only by small quantities of fluid food given by the mouth.

(*c.*) After **Ovariotomy**, there is also need for keeping the alimentary canal as quiet as possible to give rest, and especially to avoid sickness, lest the muscular efforts of retching should tear open the recent wound, and should start hæmorrhage. Dr. Keith's plan is to give only a few tea-spoonfuls of water, cold, if there be a tendency to sickness, but otherwise hot, for the rest of the day after an operation. During the night, if urine is being freely passed, 3 or 4 ounces of water may be allowed. Next day, tea-spoonfuls of hot water when thirst is complained of. Should there be sickness

with thirst, water or milk and water may be administered per anum instead of by the mouth. After flatus has been passed, as it usually is twenty or twenty-four hours after the operation, the diet is gradually improved, beginning with milk and water. Nutrient enemata may sometimes be required, should tendency to vomiting continue (see p. 10).

(*d.*) *Operations on the* **Genito-Urinary Tract.**—The chief point to be attended to in the after-treatment of patients whose genito-urinary tract has been operated upon, is to diminish the acidity of the urine and lessen the work of the kidney by keeping down the albuminoid element in the food. A diet, consisting chiefly of milk and starchy foods, is best for this purpose. When the kidney has been injured, the bowels must be kept open. Fœtid urine may be improved by the free administration by the mouth of boracic acid (½ oz. sat. solution every three hours), sulpho-carbolate of soda (20 grs. every two hours), naphthalin, and probably also by sandal-wood oil and copaiba, as well as by the injection of weak antiseptics into the bladder.

Washing out the Bladder is often of great service when the urine is putrid, and the mucous membrane unhealthy. Some surgeons use a double-way catheter. With this instrument, fluid is injected by one of the channels, while it flows out by the other; but as the mucous membrane is not thus distended and its folds exposed to the fluid, we prefer the ordinary single-way catheter.

The fluids at first used must be warm (80° to 100° F.) and unirritating antiseptics—*e.g.*, 1-4000 corrosive sublimate lotion, half strength boracic lotion, or 1-200 carbolic acid; quinine 2-3 grains per ounce, with 1 min. dilute sulphuric acid per grain; iodoform 2-4 grains per ounce, with a little mucilage to suspend it (*Erichsen*).

When the urine is no longer septic, astringent injections may be required—acetate of lead, ¼ grain to ʒi (in urine alkaline and depositing phosphates, *Thomson*); nitrate of silver, ¼ to ¾ grain to ʒi; tannin, 1 grain to ʒi.

The *quantity* of fluid injected must depend on the state of the patient's bladder—as much as can be borne without much inconvenience. Sir Henry Thomson limits the amount to 2 ounces.

A catheter (soft for preference) is passed into the bladder, and the urine drawn off. The selected fluid is then injected with a syringe (Higginson's ball or ordinary piston syringe), or is allowed (by syphon or water-head, see p. 9) to flow in from a height of 1 or 2 feet at most. It is then allowed to escape, and is probably at first turbid; the process is repeated until the returning fluid is clear. Foulis has introduced a simple and cheap apparatus for washing out the bladder (Fig. 1). He attaches a stopcock to the lower part of a common-handled mug, holding a pint. From the stopcock he leads an india-rubber tube to the catheter, to the end of which he fixes a T-tube. In washing out the bladder he has only alternately to open and close the end of the T-tube, and fluid will enter or leave the bladder as desired.

(*e.*) *Operations on the* **Mouth** *or* **Jaws.**—After extensive opera-

tions in this region, the difficulty of feeding the patient may be considerable. Mastication is generally impossible, and swallowing nearly so, as well as painful.

Frequent cleansing of the mouth with Condy's fluid or boracic lotion is a source of great comfort to such patients. A nurse may

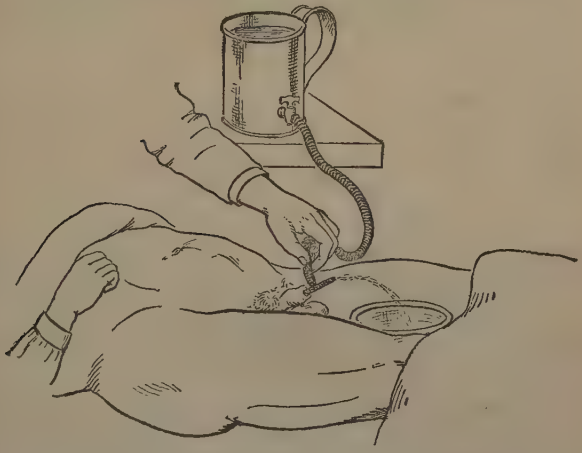


Fig 1.—Washing out the Bladder. Foulis' Method.

syringe the parts freely three or four times daily, or a syphon with clamp or stop-cock may be laid close to the patient's bed, so that he may wash out his mouth himself as often as he pleases.

Difficulties in Administering Food: How to meet them.—Under these circumstances, liquid food must be administered, (*a.*) *through a tube by the mouth*, or (*b.*) *per anum.*

(*a.*) Sometimes at the end of the operation, a gum-elastic or soft rubber catheter (about No. 12 to 18) is passed either through the nostril or the mouth into the œsophagus, and is held in position by a stitch. In other cases the House Surgeon or nurse passes a similar tube each time the patient is fed. The food will generally consist of milk, beaten-up eggs, beef-tea, thin arrow-root, and (if necessary) alcohol in the form of brandy or whisky. It is needless to say that, if a tube has to be daily passed, care must be taken to ensure that it enters the œsophagus and not the trachea. It has happened that the patient's lungs have received the food meant for the stomach—an accident which involves nearly certain death, either by immediate suffocation or rapid pneumonia.

(*b.*) *Rectal Alimentation* is at best a poor substitute for feeding by the mouth. Life may be sustained by it, however, for several

weeks and even months; and in certain circumstances the rectum becomes the only available channel for introducing nourishment into the system.

The physiological facts on which the proper management of rectal alimentation depends, are briefly: that while the *absorptive* power of the large intestine is very great, *digestive* powers may be considered to be wanting in its juices altogether, and that, as its chief function is expulsive, fluids or solids introduced per anum, large in amount, or with irritating qualities, will be expelled before absorption can occur.

Nutrient Enemata should, therefore, be pre-digested, should be small in amount (from 2 to 6 ounces), should be injected slowly, and as nearly as possible at the body-temperature (95° to 100° F.) Under favourable conditions, a reverse peristalsis seems often to occur, and the materials of enemata injected shortly before death have been found afterwards at the cæcum.

The *food injected* should be (1) peptonised albuminoids, in the form of peptonised meat-juices sold ready for use (Johnston's, Darby's, Brand's, &c.); beef-tea, or white of egg, digested with pepsin and hydrochloric acid, or more conveniently with Benger's Liquor Pancreaticus, or some of the peptonising powders sold by chemists—(Fairchild's and the zymine powders sold by Messrs. Burroughs & Welcome act admirably); (2) Diastased starch in the form of prepared malted foods, or starchy foods acted on by malt extract, or by artificial pancreatic juice; (3) Or the combination of starchy and albuminoid foods contained in peptonised milk, or peptonised milk-gruel (*v.* Roberts' directions given along with Benger's Liquor Pancreaticus).

Peptonised suppositories are a convenient form by which albuminoid substances may be administered.

To lessen the irritability of the rectum, all fæcal matter should be cleared out from it by an enema of warm water, with or without soap, before rectal alimentation is begun, and from time to time during its progress.

The same care in maintaining an excess of carbohydrate over albuminoid food (in proportion of about 4 to 1) must be taken in dealing with this, as with the ordinary mode of feeding by the mouth.

Nourishment: General Hints on.—Speaking generally, the nourishment of patients recovering from an operation is to be maintained on the principle of giving nutrition without increasing the nitrogenous waste. Beef-tea, chicken-broth, and other meat-infusions are recognised as stimulants to tissue-change rather than foods proper. They should not be omitted; but starchy foods should be chiefly relied on, and it should be remembered that meat-infusions alone will cause more rapid wasting than no food at all.

In *feverish conditions* (septic and otherwise) the digestive juices lose their power—hence the indication for giving artificially-digested foods in extreme cases. When the mouth becomes dry and parched

for lack of saliva, arrow-root, rice, and other starchy foods are contra-indicated, unless previously acted on by malt or pancreatic extract (*Chambers*). In these cases, the use of artificially-prepared foods specially intended for infants will be found of service. The various kinds seem to have this in common, that they contain starchy foods more or less changed by malting (Mellin's, Angell's, and Savory & Moore's, are all highly recommended).

CHAPTER III.

ANÆSTHETICS: GENERAL AND LOCAL.

Contents.—The Condition suitable for Operation—Importance of Personal Experience in the Administration of Anæsthetics—(1) Chloroform: Mode of Administration—Dangers and Cautions—Respiratory and Cardiac Complications: how to meet them—(2) Ether: Administration of (*a.*) by the "Open," (*b.*) by the "Closed," Method—(3) Cocaine—Caution!—(4) The "Bloodless" Method of producing Local Insensibility.

THE drugs most commonly employed for the production of general anæsthesia are chloroform and ether.

The condition suitable for operating, is that in which the patient is said to be "under." This implies muscular relaxation, and the cessation of all reflex motion, other than that associated with respiration and circulation.

Short of this stage, it is not safe to operate. While sensation remains, shock might readily ensue, and a reflex inhibition of the heart through the vagus might cause death. If the administration of the drug be pushed too far, respiratory paralysis arises, and this in its turn is followed by stoppage of the heart, if preventive measures be not at once adopted. Hence, the administration of an anæsthetic involves grave responsibilities, requires the undivided and unceasing attention of the administrator, and should only be carried out by, or in the presence of, a qualified practitioner. Although the risk which attends the *careful* administration of chloroform or ether is but small, it is difficult to exaggerate the perilous position of the patient where due care is *not* exercised. The student should seize every opportunity of giving anæsthetics, as nothing short of actual experience can give him the necessary self-reliance and watchfulness.

(1) **Chloroform** is the more potent and useful of the two drugs. By far the greater number of accidents which occur with it are due to an over-dose, or to lack of care on the part of the giver. In poisoning from chloroform, it fortunately happens that the respiratory

centres are usually involved before the cardiac, and hence embarrassed or shallow breathing—which we can readily obviate—foretells immediate danger, and gives rise to the simple rule—"Watch the breathing." Very rarely does the heart stop first, or suddenly, without warning. This does, however, happen. It has been associated with operations in the region of the fifth nerve, when the patient was not deeply under the influence of the drug, with epilepsy, and where special idiosyncrasies may have existed. Chloroform is only contra-indicated in all cases of weak, irregular, cardiac action—be the cause of this what it may—fatty heart, anæmia, shock, fear, depression, or old age.

Mode of Administering Chloroform.—The more simple the apparatus used by the chloroformist, the better. A small towel, a pair of common artery-forceps to pull forward the tongue, should occasion arise, together with a hypodermic needle and ether for emergencies, constitute his requirements.

The towel possesses the advantage of allowing one to study the face, and feel the breathing directly.

It should be folded into a square, and about an inch of its margin turned up so as to form a pad or roll, which may be laid against the chin, and kept free from chloroform. The patient's stomach should be empty. It is better for him to have had no food for at least four hours prior to operation. He should lie on his back, with the head comfortably supported on a pillow, and all clothing encircling the neck and chest should be loosened. About a dram or two of chloroform is now to be sprinkled over the towel; the patient is told to breathe easily and close his eyes, and the towel is gradually raised in front of the face. If the patient feel uneasy, or if he should complain of choking, the towel should be withheld for a moment till a full inspiration of pure air has been taken. If there be an accumulation of saliva in the mouth, he is asked to spit into a towel. Quiet should always be maintained, since the sense of hearing is sharpened by chloroform, and since the period of excitement which ushers in chloroform-narcosis is often increased by external agencies. Should the patient become greatly excited, it is not advisable to struggle against him. On the contrary, he should be allowed to grasp the hands of an assistant, who will follow and guide his movements. Securing the patient to the table before he is "under," or other restraint of any kind only provokes resistance.

In some people, more especially in drunkards, the stage of excitement is often prolonged; and as the patient struggles and holds his breath, the veins become congested and turgid, and a species of tetanic spasm sets in, during which the respiratory muscles are apt to become fixed. Under such circumstances, the towel should be removed until the patient has cleared his lungs of the chloroform-vapour, and once more breathes with regularity; by that time the administration may be resumed again with safety, the congestion and spasm having passed off. As soon as the patient rests quietly, and no longer responds to pinching, his limbs lying limp and motionless, his conjunctival reflex may be tested by raising the upper

eyelid with one finger, and touching the globe with the other. If the patient does not wink, the chloroform should be at once withdrawn, the patient is "under," and the operator may begin. At short intervals more chloroform should be given, as signs of returning sensibility are recognised, such as conjunctival reflex. The eyes should not be fingered too much, lest their sensibility become impaired, and the delicacy of this test be lost. It sometimes happens (as, for example, in children), that the conjunctiva is of little use as a guide, in which case the local sensibility and muscular relaxation will serve instead. When the patient is "under," the pupil is contracted; it dilates as he recovers, but we must bear in mind that also during profound and dangerous anæsthesia it becomes widely dilated.

Dangers and Cautions!—Certain troubles and dangers are apt to embarrass the chloroformist. These are, firstly, *respiratory*—the sudden, or gradual stoppage of breathing; secondly, *cardiac*—syncope, or complete cardiac failure.

(*a.*) **Respiratory Arrest**, when *sudden*, is frequently due to the presence of some foreign body in the mouth, lodging in the larynx. It is in order to avoid this that it is necessary to remove false teeth, and search the mouths of children for sweetmeats, prior to giving an anæsthetic; similarly gags, sponges, and mouth instruments should be examined lest part may have become loose. The tongue itself may suddenly fall back and so obstruct respiration. If so, by pulling forward the chin, and turning the head on one side, the tongue is prevented from becoming an impediment; and if the condition does not at once yield to this simple manœuvre, the mouth should be opened and the glottis explored with the finger. Note that the chest may heave although no air is entering the lungs; hence the necessity for *feeling* the breath with the hand over the mouth.

Gradual stoppage of breathing is usually associated with over-dose. In poisoning of the respiratory centres, the breathing becomes shallow, irregular, and laboured—all of which signs are evident enough to the attentive administrator. Or, again, there may come on closure of the glottis, associated with crowing, "croup-like" breathing, which at once gives the alarm. The treatment after pulling the chin forward is, with common artery-forceps, to seize the tongue firmly, and *forcibly* pull it forwards. This causes the glottis to expand, and reflexly stimulates respiration. In every case where there is no response to the treatment, artificial respiration should be at once carried out.

Sickness and vomiting are dangerous from the risk of ejected material gaining access to the air-passages. Intermittent administration and shaking and movement of the patient, favour sickness. If the stomach contain food or fluid, the patient should be turned bodily on his side and allowed to vomit, after which the chloroform is again resumed. If there be no food, chloroform is pushed in order to abolish the reflex act.

(*b.*) The **Cardiac Complications** are, in the first place, those associated with, and secondary to, difficulty of breathing, when the

right heart becomes distended and general congestion occurs. We have already alluded to this, as seen in the case of drunkards. It is enough to remove the towel and encourage respiration. In anxious cases, the external jugular vein may be opened; or, if the heart have stopped, the right ventricle might, as a last resort, be punctured with the hypodermic needle, blood withdrawn, and the endocardium at the same time stimulated. Extreme pallor and irregular and feeble pulse presage cardiac syncope, for which ether may be given, either hypodermically or on the towel. Sudden heart-failure is not prone to occur when the patient is well "under."

It will be noted how much can be learnt by watching the aspect of the patient's face. The pallor of syncope and sickness, the congestion of respiratory embarrassment must be well watched, in contrast with the normal colour of the lips and ears. To sum up: we expect that no operative procedure whatsoever should take place till the patient is fairly "under;" that as soon as he *is* under—as evidenced by the muscular relaxation, cutaneous insensibility, and loss of conjunctival reflex—the anæsthetic should be at once removed; and that in the event of any respiratory trouble arising which is not at once relieved by pulling forward the chin, or by forcible traction on the tongue with artery-forceps, the alarm should be given, and artificial respiration promptly begun.

It is difficult to form an accurate judgment as to the beneficial results gained by the preliminary hypodermic injection of *atropia* and *morphia*. There does not seem to be sufficient evidence as yet, that danger or sickness is lessened by it. Where, however, extensive operations have to be performed in the region of the mouth and jaws, the patient's sufferings are mitigated, and less chloroform is required by this mixed narcosis. Moreover, the operator may be greatly assisted by the patient clearing his mouth while still remaining insensible to pain.

(2) Ether is held in favour as the safest anæsthetic by many surgeons, notably so in England and America. It would appear, however, that in this respect its virtues have been exaggerated, and fatalities during its use are not extremely rare, as is shown by some recent American writings.

It may be used with advantage where chloroform is contra-indicated. It should not be employed for children, who always bear chloroform well and safely. It is contra-indicated in cranial surgery, since it congests the brain; and it is open to similar objections in pulmonary and renal weakness, where it is more or less obnoxious from chilling the lung or irritating the kidneys.

There are two methods of giving ether, known respectively as the "Open" and the "Closed" methods.

(*a.*) *The "Open" Method.*—This resembles the ordinary mode of giving chloroform. The ether is either poured on the hollow apex of a towel rolled into a cone, or on a sponge placed within the towel, and the cone is then held over the patient's nose and mouth. The ether is renewed as required, and care similar to that exercised in the administration of chloroform is carried out. As a rule, the

stage of excitement is more pronounced, the face undergoes peculiar vascular changes, and the administration requires to be more continuous than with chloroform. For the open method, Allis' ether-inhaler has certain advantages. It consists of a light metal framework, on which a bandage runs vertically in a zigzag manner, the whole being surrounded by a strong rubber collar. This is placed over the respiratory passages, and the ether dropped continuously on the bandage.

(*b.*) *The "Closed" Method* possesses the peculiarity of requiring that the patient should breathe and rebreathe his own expired air, so that partial asphyxia is made use of as an anæsthetic; less ether is required, and there is not so much chilling of the lungs. It is carried out by means of a special inhaler—*Ormsby's* or *Clover's* being commonly employed.

Such inhalers consist of a mask or face-piece, to which is affixed a rubber bag, into which and from which the patient breathes. There is an interpolated chamber or sponge for ether, so that the respired air is thus charged with the anæsthetic. The air-pad of the face-piece should be blown up and soaped, if the patient possess a beard, so that it may securely fit when pressed down firmly on the face. In the case of the Clover's Inhaler, the ether-chamber is charged with a measure of ether, and the index turned so that the patient breathes and rebreathes into the rubber balloon. After one or two respirations, the administrator gradually turns the index so that ether is admitted, and by degrees a quarter, half, and finally, all the air breathed consists of ether vapour, the face-piece being closely pressed down. By means of a valve a little fresh air may be given when necessary, but this is most readily accomplished by removing the mask.

Sickness after anæsthetics, when obstinate, may be cured by giving the patient very hot water to sip, or by the administration of an eighth of a grain of morphia in pill, with perhaps a little cocaine.

(3) **Cocaine.**—For the production of local anæsthesia there is no agent equal to the new drug, cocaine. Care should be taken to obtain a good pure preparation, since the impure forms are highly irritating. Two solutions are commonly employed, a 10 per cent. and a 5 per cent. These should be freshly prepared by dissolving 1 or 2 grains of cocaine in boracic acid lotion, as required.

(*a.*) *The stronger solution* is used for external application to mucous surfaces; it does not penetrate ordinary cutaneous epithelium. It may be sponged, painted on, or rubbed in with a pledget of lint or wadding. The latter method gives the more rapid and lasting effect, but the application will vary with the accessibility of the part. Thus, we drop the solution on to the conjunctiva, spray the nostrils and throat, rub the tonsils and pharynx, and so obtain insensibility prior to interference with the eye, or throat, or when using the laryngoscope, or removing tonsils, &c. In painful dysphagia due to ulceration, its action is most beneficial.

(*b.*) *The weaker solution* is for hypodermic use. Five minims should be injected at the spot selected, the needle left *in situ*, and as sensation becomes dulled, the point may be radiated as required,

and further doses introduced. In this way about a grain to a grain and a half may be injected. Over 2 grains may give rise to inconvenience, and, indeed, it is to prevent an over-dose that the weaker solution is preferred for hypodermic use. Anæsthesia, as in the case of mucous membranes, is complete in about five minutes, and lasts for about five minutes longer. We are thus enabled without pain to open abscesses and hydroceles, shell out cysts and fatty tumours, excise epithelium of the lip, amputate fingers and toes, and practise circumcision. The great value of the drug in anal surgery is marked. The patient can strain and aid, while operations are being performed for piles, fissure, fistula in ano, or polypus.

A solution (10 per cent.) injected into the urethra, or the introduction of a bougie of cocaine and cacao-butter, five minutes prior to instrumentation, often largely obviates pain.

Caution.—It would appear that some people are highly susceptible even to moderate doses of cocaine. In such, it gives rise to disagreeable, if not dangerous symptoms. The patient becomes pale, and syncope threatens; or, again, he may turn dusky or livid. Giddiness, cardiac irregularity, retching, delirium, unconsciousness, and collapse, have been noted. Treatment consists in laying the patient at full length, giving stimulants and heat; good has also been obtained by inhalation of nitrite of amyl.

(4) *Local Insensibility by the Bloodless Method.*—Local anæsthesia may also be produced by rendering the part *bloodless* after Esmarch's method, and freezing with the ether-spray. The subsequent thawing is, however, very painful, and cocaine has now entirely superseded this method.

CHAPTER IV.

ANTISEPTICS AND WOUND-TREATMENT.

Contents.—Antiseptic Treatment and the Germ Theory—**A. General Antiseptic Principles and Practice**—Antiseptic Materials—Isolation—Cautions necessary in the use of Antiseptics—Various Antiseptics and their Relative Advantages: Carbolic Acid, Corrosive Sublimate, Iodoform, Boracic Acid, Chlorate of Zinc, &c., &c. —Use of Antiseptics during Operation—Antiseptic Ligatures, Dressings, and Strapping.

A. General Antiseptic Principles and Practice.

THE whole question of the treatment of wounds turns upon the differences which obtain between a compound and a simple fracture, an injury with skin broken and one in which it remains intact. All surgeons endeavour to bring wounds into a condition comparable

with that in which the skin is unbroken. Speaking generally, we may say that inflammation does not attend subcutaneous injuries. Wherever the skin is destroyed, however, external noxious agents are brought into contact with the injured tissues, and inflammation and fever ensue. This is entirely due to the growth and development in the wound-secretions of micro-organisms, which, abounding more or less in the atmosphere, are deposited everywhere. These germs vary in number, quality, and vitality—many of them, more especially those associated with putrefactive changes, thrive in dead or dying tissue, aided by moisture and heat, conditions which they find in wounds. It is against such organisms coming directly from without that the surgeon battles.

A second series of microbes, not only attack wounds from without, but often gain entrance to the system through the alimentary, respiratory, and other tracts. Many of these give rise to special diseases, such as tubercle, and the like. Sometimes they retain their vitality in the tissues and the blood-stream for a considerable time, and only give direct evidence of their presence by congregating and multiplying at spots where there has been some local injury sustained, or where some local weakness exists. It is in this way that we explain the micro-organismal formation of abscess.

If inflammation and blood-poisoning, ensuing on the receipt of a wound, be thus caused, it follows that all successful wound-treatment is based upon a recognition of the germ-theory, and should be conducted entirely on the antiseptic principles of Lister. Hence, our object is not so much to treat the wound itself, as its surroundings. We must either destroy the germs when they have gained entrance, and thereafter exclude them; or we must render the wound an unfitting nidus for their growth, or entirely prevent their entrance.

Antiseptic Methods and Materials.—The antiseptic methods and materials used by different surgeons vary considerably. The *principles* are the same. The surgeon's hands and those of his assistants, the instruments, sponges, and everything which is brought in contact with the wound must be carefully purified and rendered antiseptic, as is also the skin of the part operated on. The surgeon either operates under a cloud of carbolic spray (1 to 30); or irrigates the wound with some antiseptic lotion; or does not act on it in any way beyond drying and draining it. In the last instance, he trusts to the dryness of his wound and the vitality of the tissues, which have not been irritated by applications, as being sufficiently inimical to any stray organisms which may have entered. Bleeding vessels are twisted or tied with purified catgut or silk; drainage-tubes are inserted, and the wound is closed.

Some surgeons contrive to leave their wounds untouched for fourteen or twenty days after operation, and then remove the dressing to find all healed. This end they attain by the most scrupulous attention to antiseptic detail, and by the use of trustworthy catgut and decalcified bone tubes. Others, again, dress always at the end of twenty-four hours, and then remove the drainage-tubes. They again dress about the seventh day, to remove

the sutures. Naturally, the number of dressings will vary greatly with the case, and the surgeon. Much depends on applying a plenteous supply of an absorbent, elastic, porous, soft dressing, which admits of sufficient pressure by bandages to obliterate every cavity, and bring the divided surfaces into apposition.

In many cases, no drain is required. In the case of the abdomen, the peritoneum carries off secretion. Where wounds are a-septic, the cut surface not too extensive, and where careful dressing has obliterated every cavity, no artificial drain is required. It sometimes happens, however, that a little discharge does take place, and this by evaporation may cake on the dressing, dam up some further residue, and thus create tension. Hence, a drainage-tube should be used in all doubtful cases, for at least twenty-four hours.

Isolation.—As at present carried out, the antiseptic treatment is of necessity bound up with questions of cleanliness and hygiène, since the presence and deposit of dust are highly obnoxious. Moreover, as it is mainly preventive in its character, isolation or separation of septic and specific cases is to be observed, when convenient. In regard to erysipelas this isolation is imperative. Hence, walls, roofs, and floors should have smooth polished surfaces, which can readily be washed down. Cornices, inaccessible picture-frames, shelves, and ledges, are all condemned as harbourers of dust. The staff and dressers brought into immediate relation with the patient should have fresh clean clothing. They alone are allowed to assist, and they are ever on the alert to see that nothing employed comes in contact with other than antiseptic surfaces; this care is specially directed to the instruments, ligatures, and sponges. The operating theatre or room should be well stocked with suitable lotions, thoroughly dissolved, and recently (but not hurriedly) prepared; where the spray or irrigation is not employed, the attendance of visitors engaged in dissection or pathological research, is not to be encouraged.

Cautions necessary in the use of Antiseptics.—Before proceeding to describe the various antiseptics in use and their application, one word of caution.

The more potent the antiseptic, the more likely is it to react injuriously on the tissues; and hence poisonous effects often follow when Carbolic acid, Mercurial salts, or Iodoform become absorbed.

Some patients are peculiarly liable to disastrous effects, even from small doses, and where such idiosyncrasies are displayed, the offending drug must be at once removed, its effects antagonised, and a milder and less irritating antiseptic substituted for it. Care should be taken that pure preparations of all the various drugs are alone used.

Various Antiseptics: (a.) Carbolic Acid.—By far the most useful antiseptic, and certainly that of most general application, is carbolic acid. It is volatile, searching, and does not damage instruments like the preparations of mercury. It is used in the form of lotion by dissolving pure phenol in water. The strong solution (1 to 20) is used for purifying the skin, sponges, towels, and instru-

ments. The weaker solution (1 to 40) is employed in connection with parts and instruments already purified, and for irrigation. A solution in the proportion of 1 to 15 is used for the spray, which is diluted with a cloud of steam to the strength of 1 to 30. Carbolic acid is used as a dressing in the form of gauze. Carbolic acid in oil or glycerine is frequently used for catheters and dressings (see *Appendix*).

Caution!—Carbolic acid poisoning exists in varying degrees. The passage of urine which is olive-green, and which darkens gradually on standing, is the first indication of carbolic acid absorption, and is in itself of little moment. Headache, giddiness, and sickness, are of greater import, more especially when these are associated with the absence of sulphates from the urine. In extreme cases, low temperature, extreme depression, and collapse ensue. Treatment consists in a change of dressing, together with the administration of sulphates, which, it is hoped, will combine with the free carbolic acid in the system, and be excreted as harmless phenol-compounds by the kidneys. In addition stimulation may be required.

(b.) Corrosive Sublimate is at present one of the most universally employed antiseptics, being cheap, effective, non-volatile. It, however, corrodes all metals, and hence, can only be used in glass, porcelain, or vulcanite. In solution, 1 to 500, it has been used for the hands and skin, but in this strength is rather irritating. 1 to 1000 is the stronger form of solution used for general purification, while 1 to 2000–5000 is that employed for irrigation. When used to purify septic wounds, it should be employed in large quantity, as the mercury is speedily used up by forming compounds with albumen, and the lotion is thus apt to become inert. The addition of common salt to the solution, prevents this action.

Absorbent wool, gauze, jute, and wood-wool, are all to be had charged with Corrosive Sublimate, and make excellent dressing-materials.

Caution!—Corrosive Sublimate solutions must be used with the greatest care. It is probable that more deaths have occurred from the use of mercurial salts as antiseptics, than from that of carbolic acid. Irrigation of absorbing surfaces—as, for example, the tunica vaginalis and pleura—is fraught with danger. Diarrhœa, vomiting, collapse, and death may rapidly ensue. Large moist dressings of corrosive must always be avoided. If evaporation be prevented, then the skin becomes irritated, and absorption rapidly follows.

In order to obviate the danger so often produced by corrosive sublimate, other compounds as effective and perhaps less irritating have been advocated. Amongst these we may mention sal alembroth, and biniodide of mercury.

(c.) Iodoform has obtained a great reputation from its marked deodorising properties, and from its supposed special action in tubercular inflammation. It should be lightly dusted over the wound. The fine sublimed crystals, mitigated with boracic acid or bismuth,

are most suitable for this. It is insoluble in watery solutions, but dissolves in chloroform, ether, and oils. It has almost entirely replaced chloride of zinc in operations about the face and perinæum. Nussbaum recommends a solution of iodoform (iodoform, 10; sulphuric ether, 70; distilled water, 200) for washing out foul cavities.

Caution!—Iodoform should always be used with great discretion. There is no occasion to apply it in large quantity to wounds and absorbing surfaces. Children, as well as old and weak people, are especially liable to be affected injuriously by it. Fatal results have followed from its accumulation in the deep recesses of wounds after insufflation. The symptoms vary from sudden collapse, associated with brain-symptoms and vomiting, to milder forms of loss of appetite, mental depression, and excitement. When the patient complains of feeling its taste and smell in everything, its use must be discontinued, and the patient stimulated and treated to plenty of fresh air.

(d.) **Boric, or Boracic Acid,** is one of the mildest and most unirritating germicides we possess. It may be used in saturated watery solution (1 to 30), or dusted on copiously when finely powdered. It is specially applicable in open wounds after their preliminary purification with stronger agents, and highly suitable for irrigating the bladder. It is practically non-poisonous. For Boric Ointment, see *Appendix*.

(e.) **Chloride of Zinc,** in the strength of 40 grains to the ounce of water, is a most potent and lasting disinfectant. It is a valuable medium with which to soak strips of lint for use as plugs after operations in the vicinity of the oro-nasal cavities. It will maintain its action for forty-eight hours. It is, however, somewhat painful, and latterly iodoform, or iodoform mitigated with boric acid or bismuth, has supplanted it to a great extent.

(f.) **Other Antiseptics.**—Amongst the many other powerful antiseptics, all of which have had their advocates, we may mention *salicylic acid, benzoic acid, thymol, acetate of alumina, naphthalin, subnitrate of bismuth, iodol, and eucalyptus oil.* The latter is largely used in place of carbolic oil for disinfecting catheters, as being less irritating.

Mode of using Antiseptics during Operations.—Previous to operation, the skin should be washed with soap, and shaved, the razor acting like the *stirgil* of the Roman bathers, and then thoroughly scrubbed with carbolic lotion (1 to 20). The skin-purification should be thorough. For this many employ a preliminary washing with turpentine or some alkali. It is always good, when circumstances permit, to have a towel soaked in carbolic, bound over the spot, for at least thirty minutes before operating (see *ante*, p. 6). The patient should be warmly covered with blankets. By spreading one or two sheets of mackintosh or guttapercha, covered with carbolised towels, over the blankets, &c., in the vicinity of the field of operation, an antiseptic area is provided, whereon instruments, &c., may be laid with safety. A mackintosh beneath the patient serves to protect the blanket. Everything being

in readiness, and the patient "under," the surgeon proceeds to operate.

If the steam spray be used, it is now turned on. It should be provided with a couple of independent nozzles, as they are apt to become choked with dirt. To prevent this a small piece of sponge as a filter should be secured to the ends of the rubber tubes conveying the carbolic lotion (1 to 15). Should the nozzles become blocked, they must be unscrewed, and a fine silver wire passed through from the fine point inwards, so as to remove the impacted particle.

Let us imagine that the surgeon has to deal with a chronic abscess. After opening it, he inserts his purified finger, and explores it thoroughly with the view of removing any necrosis or other source of irritation, and scraping away the so-called "pyogenic membrane." If he thinks it better to get rid at once of the organisms (micrococci and tubercle bacilli) which exist in the abscess-wall, he irrigates and then performs as far as he dare previous to draining; otherwise, he contents himself with draining, trusting that now the tissues will recover their vitality, and that efficient drainage will act as an antiseptic by removing material in which organisms may grow. Where the spray is not used, it is customary to irrigate; and under any circumstances the blood-clot and *débris* may be with advantage washed away. In incised wounds ligatures should only include the bleeding vessel, and should be cut short, so that as little devitalised tissue as possible may be left in the wound. In the case of compound fractures and joint-wounds, where the recesses have been manifestly exposed to septic influences, most thorough and prolonged irrigation must be used. The skin should also be shaved and purified. Where dirt and sand have been ground into cartilage and bone, the bone-pliers and knife may be used to remove the engrained tissues. Do not otherwise remove bone, even although loose. If sepsis be conquered, the weak part will live. Free incisions may be made to avoid tension, and drainage-tubes inserted. Where a sharp edge of bone projects, which has been exposed and cannot readily be replaced, it is well to remove it with the forceps or saw.

Antiseptic Ligatures and Dressings.—Catgut ligatures, prepared according to the various formulæ in the *Appendix*, are to be used. A difficulty arises in getting good catgut, and it is better that the surgeon should prepare his own. The longer it is stored, the better. That supplied by the instrument-makers is often unreliable, and is a fertile source of wound-infection. Under these circumstances some have preferred to use purified silk, fine Chinese twist, or Turner's plaited surgeon's silk. As shown by Lister, this, when a-septic, becomes also gradually absorbed in the tissues. The process is, however, much slower than with catgut, and the fragments of silk, remaining unabsorbed, have a tendency to irritate and act as foreign bodies, giving rise to small abscesses. The finer the silk, and the smaller the amount left in the wound, the less risk there will be of this. Should sepsis take place, the silk

ligatures invariably slough out. Antiseptic silk is simply prepared (see *Appendix*). Strips of fresh ox aorta, kangaroo tendon, and allied animal textures have been prepared like catgut. The closure

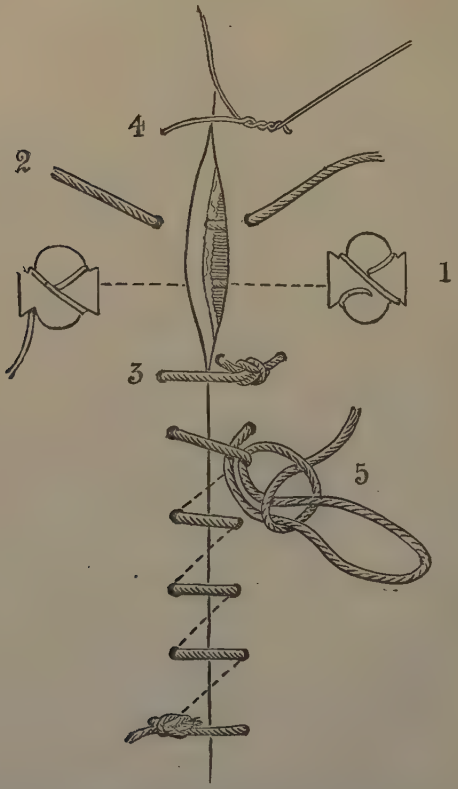


Fig. 2.—Methods of Closing Wound.—1, Lister's button suture; 2 and 3, interrupted suture; 4, suture of horse hair, showing double twist; 5, continuous suture.

of the wound is effected by sutures of catgut, which become absorbed, or by silk, horse-hair, or wire, which require removal. In stitching, where there is much tension, a few deep sutures may be

used in order to secure the lips of the wound free for the closely applied stitches of apposition. These deep sutures may be on the plan of Lister's "Button" suture (Fig. 2). The margins of the wound should be closely and accurately applied, each epithelial edge meeting its fellow, and no fat protruding. In wounds which unite by the first intention, and which are a-septic, the "Continuous" suture may be used. It is finished off by slipping the doubled end of the suture under the last stitch, and tying over that (Fig. 2). The continuous suture is well adapted for closing intestinal wounds in emergency cases, on account of the rapidity with which it may be applied. A double row of sutures is often valuable in closing wounds of the intestinal canal, and the method is illustrated in Fig. 4. The principle to be carried out in stitching up the bowel is, that serous surface must be brought to meet serous surface by stitches which do not transfix the mucous aspect. Such is the well-known "Lembert's" suture (Fig. 3). All sutures which

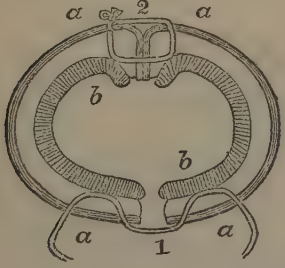


Fig. 3.—Lembert's Suture for the Intestine.—The stitch perforates the serous surfaces (*a*) twice on each side, but does not penetrate to the mucous layer (*b*). 1, Suture passed; 2, Suture tightened.

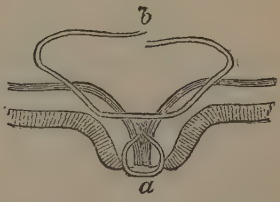


Fig. 4.—Czerny's Double Suture.—The first stitch unites the divided edges (*a*); the second brings the serous surfaces together (*b*).

bear much tension will ultimately cut their way out; therefore, such as, for example, button sutures, should be removed at an early date. On the other hand, the stitches of apposition which should be free from tension may be left in longer. In any case, an area of redness round any stitch calls for its removal.

Drainage is carried out by means of ordinary rubber tubing, glass tubes, or by media which become absorbed, as decalcified bone tubes (see *Appendix*) or prepared catgut. Where the drains are not absorbed, there is a great advantage in making separate apertures for them at the most dependent part, encouraging union by the first intention along the line of incision. A dependant aperture is made by thrusting a closed forceps through the tissues,

till the skin is tense over it, and then incising. In this way all fear of injuring important structures is reduced to a minimum.

To finish the Dressing.—Over the stitches a layer of "Protective" may be placed, which keeps the edge of the wound moist, and allows discharge to escape without caking into the dressing beyond. The original object of the protective, as its name implies, was to defend the edges of the wound from the antiseptic in the dressing. With dry dressings, however, an efficient covering for the lips of the wound is found in three or four folds of soft unprepared gauze, which has been steeped for 24 hours in some antiseptic lotion, and which is squeezed dry prior to application. This does not adhere, and remains soft and pliant. Over all, the pads of dressing are placed with intelligence, arranged so as to receive the discharge and to press together the sides of cavities. Finally, a firm bandage, splints, and other supports, as need be.

Treatment of Discharge.—Should discharge appear at one spot, the surface there may be touched with an antiseptic lotion and a fresh pad put over all. If the discharge be in quantity, a new dressing is required.

General Remarks.—With absorbent drains and stitches, all may be left untouched for an indefinite length of time should a favourable course be pursued. When ordinary tubes and sutures have to be removed, the tubes may be taken out in 24 hours, the deep stitches on the third, and superficial on the seventh days. A slight rise of temperature generally takes place on the second or third evening in any case, but there is no occasion to dress unless something has gone wrong with the wound, as is evidenced by the rise being over 100° F., quickening of the pulse, local pain or disturbance, without other known cause.

Moist dressings may be used in septic cases, and where there is a copious discharge. They consist of ordinary dressings applied moist and covered with guttapercha or mackintosh.

Attempts to carry out a thoroughly a-septic surgery, that is, the ideal treatment, where one would operate in an a-septic room with a-septic surroundings and dressings, have not as yet taken a practical form. Sterile water prepared by repeated boiling should, however, always be available, since it is the best agent with which to wash out the peritoneal cavity. In its place, warmed boric lotion may be used.

Lacerated wounds which are difficult to purify, should be treated by immersion in a warm bath of boracic lotion, or corrosive sublimate (1 to 4,000). In this they may be left for three or four days, the lotion being changed from time to time. Where this method is inapplicable, a constant irrigation may be maintained with similar lotions, as in Fig. 5 (see further under *Lacerated wounds*, p. 27).

Wounds which are septic are generally accompanied by pain, fever, inflammation, and unpleasant odour.

Strapping.—Strapping is sometimes employed in lieu of stitching, or is put on when the wound shows a tendency to gape after the removal

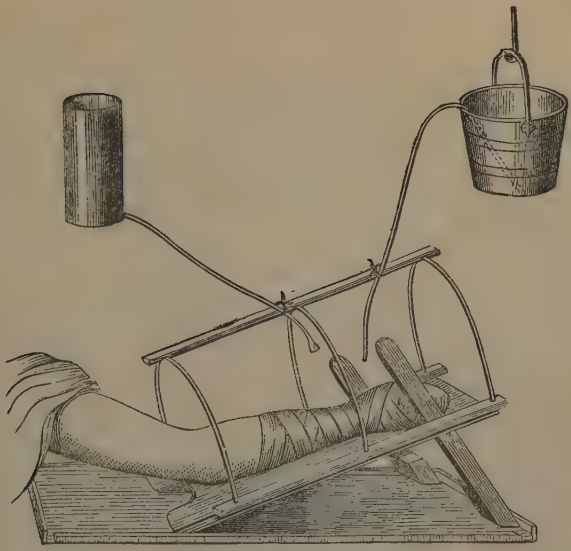


Fig. 5.—Irrigation of Wound

of sutures. Much neater and more serviceable, however, is the use of collodion with unprepared gauze. A strip of gauze should be laid over the wound, and one end of it secured to the skin by painting on the collodion with a brush. When this dries, traction may be exercised, and the skin pulled towards its opposing flap, which is pushed forwards with the fingers, and the other extremity secured in like manner to the skin. The whole extent of the incision may also be fortified by painting with collodion. Kocher combines bismuth with it, and this forms an efficient species of non-irritating plaster. A doubled fold of gauze may thus be affixed to each side of the wound, and when secured, the two may be brought together by lacing, as in Fig. 6.

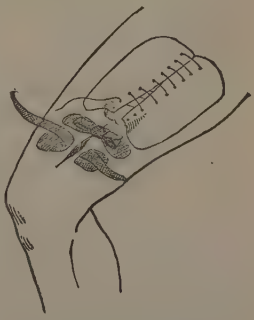


Fig. 6.—Closure of Wound with laced plaster and collodion strapping.

Strapping under an antiseptic dressing, after having been cut to the requisite size, should be washed in carbolic lotion (1 to 20). To this is then added an equal quantity of boiling water, and the plaster is now ready for application.

CHAPTER V.

ANTISEPTICS AND WOUND-TREATMENT (*Continued*).

Contents.—**B. Special Wound-Treatment.**—Gun-shot, Lacerated, and Punctured Wounds—Nerve Injuries—Burns and Scalds—Ulcers—*Skin Grafting*—Sinuses—Erysipelas—Whitlow—Blisters.

B. Special Wound Treatment.

(1) **Gun-shot Wounds.**—Gun-shot wounds in civil practice are generally caused by accidents with fowling-pieces charged with small shot, or they result from homicidal or suicidal wounds from pistol or revolver.

It need, perhaps, hardly be insisted on, that a-septicity of such wounds, as of others, is one of the most important elements in their treatment. When none of the body-cavities have been penetrated, the first indication will be arrest of Hæmorrhage, temporarily with a tourniquet, then permanently. Under antiseptic precautions, portions of clothing, wads of paper or other foreign soft matter that may have been carried into the wound should be at once removed, likewise splinters of wood and greatly comminuted fragments of bone ; the finger, properly cleansed, should be used as an exploring probe. If small shot in great numbers, or a bullet, have lodged, they should be searched for and removed, and the wound should be washed out with antiseptics. Isolated pellets may be safely left alone.

The surrounding parts should be thoroughly cleansed and purified, an antiseptic dressing applied, and the whole fixed in a splint.

Penetrating wounds *of the abdomen* are dealt with elsewhere (see Chap. ix.) When these wounds occur *in the thorax*, little can be done except to stop superficial bleeding, remove superficial foreign bodies, apply antiseptic dressing, and keep the patient perfectly quiet, resting chiefly on the injured side. *In the skull*—besides the general principles already laid down, the indications for treatment are mainly those of depressed fractures of the skull (see Chap. ix.)

Some general rules, framed for the examination of gunshot wounds in military practice, may be mentioned here.

(1) Ascertain, if possible, the exact position of the patient at the moment of injury, and the direction from which the injury came. This will greatly help diagnosis of the probable injury and the track of the shot.

(2) Examine the clothes, to see if any parts are wanting, and hence, possibly carried into the wound.

(3) Search for bullets by passing the hand lightly over possible seats.

Should symptoms of septic inflammation appear in the track of the

bullet, free incisions must be made to permit of drainage and irrigation.

(2) **Lacerated Wounds** owe their dangers to the injury as well as division of the parts affected, and to the frequency with which septic matter is rubbed into them. Even with the greatest care and trouble, it is generally impossible to purify them in the ordinary way. Consequently, the immediate dangers and subsequent troubles of sepsis are specially great.

When a lacerated wound is first seen, the surrounding skin should be cleansed and purified, and the wound itself freed from all apparent dirt, and afterwards scrubbed with either 1-20 carbolic, or 1-1000 corrosive sublimate, lotion. It may then, after bleeding points have been secured, and torn nerves and tendons brought together with catgut stitches, be protected by an antiseptic dressing. In the hand and arm, however, all doubtful cases should be immersed in a bath of warm antiseptic lotion—Corrosive sublimate lotion 1 4000 answers well, and cases kept in it for several days have in the writer's experience shown no sign of poisoning*—Carbolic acid about 1-80 or 100, salicylic acid 1-300, or boracic acid, saturated may also be used.† The fluid should be renewed daily, and every three or four hours part of it may be replaced by hot lotion, as the bath cools. The patient's head and shoulders must be propped up in bed. The bath (Fig. 7) may either rest upon the bed, or be supported alongside the bed, on a slightly lower level than the mattress.

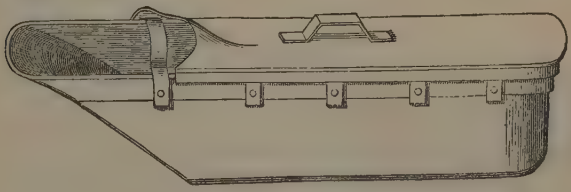


Fig. 7.—Arm Bath.

On the third or fourth day, or even sooner, the limb may be safely withdrawn from the bath, and treated with ordinary antiseptic dressings.

Many limbs and lives may be saved by this treatment which, without it, would be lost.

The difficulties involved in immersing the foot or leg in a bath (Fig. 8) are greater than those met with in immersing the upper limb. A very large metal leg-boot has also been made for this purpose, and might prove of service. Only the parts below the

* A warning of danger will be given, however, by the precipitation of an orange deposit when the urine is treated with sulphide of ammonium.

† The warning of extensive absorption of carbolic acid will be given by a greenish discoloration of the urine.

knee, however, could thus be immersed. The leg would require to be flexed at the thigh, with the knee raised.

In Vienna, bad cases of burn to the trunk have been treated by continuous immersion of the whole body. Irrigation with antiseptic lotions may be employed where the bath is not available. The method of carrying it out is indicated in the illustration (Fig. 5).

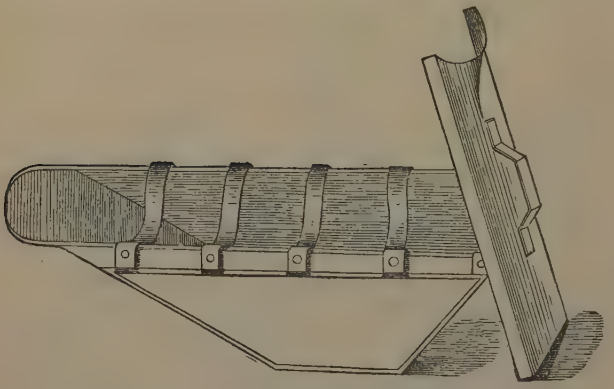


Fig. 8.—Foot Bath.

Instead of syphon tubes, two or three threads of worsted are generally enough.

(3) **Punctured Wounds**, (*i.e.* those in which the depth of the wound is out of proportion to its other dimensions), owe their danger to risk of hæmorrhage, in the first place, and to sepsis and confinement of discharge, in the second. Should there be reason, from the appearance and condition of the patient, from the state of the parts, and from the probable direction of the wound, to fear hæmorrhage, the surgeon should try temporarily to control the circulation in the part, and after enlarging the wound to find and secure the injured vessel. In an inaccessible region such as the chest, rest, quiet, cold, and internal styptics, are alone available. When rise of temperature, pain, and other signs of inflammation render the advent of sepsis probable, free incisions are indicated.

In ordinary cases, punctured wounds may be treated like compound fractures—*i.e.*, with the view of rendering and keeping them a-septic.

(4) **Nerve Injuries.**—When a nerve is completely divided, the muscles supplied beyond the point of section remain powerless until union takes place. The expected sensory disturbance may be complete, or it may be only partial, or even non-existent, because

of abnormal distribution or anastomosis. As the result of loss of the nerve stimulus, the muscles supplied by the divided nerve begin to degenerate rapidly and shrink. In recent wounds, the severed nerve-ends should therefore be carefully sought for and sutured together with fine catgut. Subsequent restoration of function ensues. In old-standing cases, there seems to be no limit in time which forbids successful suture—the first sign of repair is return of motor power.

Pressure paralysis, as, for instance, the wrist-drop due to interference with the musculo-spiral nerve in the axilla from the use of a crutch, yields to massage, electricity, and superficial stimulation.

(5) **Burns and Scalds** may be considered together as being both injuries caused by heat. They generally consist of more or less extensive injuries of the skin. The depth of tissue affected is not at first apparent, as frequently much is injured beyond what is actually destroyed.

The points to be attended to in their treatment are (1) rendering and keeping them a-septic, and (2) preserving them from every form of mechanical or chemical irritation.

Since from burns large raw surfaces frequently result, which at first are highly absorptive, the antiseptics employed must be not only unirritating but non-poisonous if absorbed. Hence carbolic acid and strong corrosive sublimate lotions are to be avoided. We may use, however, weak corrosive sublimate (1-2000), salicylic acid (1-300), or sulphurous acid (1-8 B.P.) lotions, boracic acid *ad lib.*, or eucalyptus oil, 10 per cent. After granulations have formed, the risks of absorption are much less.

Since heat is itself a powerful antiseptic agent, the affected surfaces will be at first a-septic. The surrounding skin must, however, be thoroughly cleansed and purified, and, as a precaution, the burned surface should be sponged over as well. In all cases where the a-septicity is doubtful, an anæsthetic should be given, and the part well scrubbed with an antiseptic. Blisters should be cut and the fluid allowed to escape. Small burns should then be covered with wool and flexile collodion, while larger burns may be freely dusted with powdered boracic acid, and wrapt in absorbent antiseptic cotton-wool. Should a-septicity have been ensured, no further dressing should be required. An a-septic burn heals with much less destruction of tissue, with much less local or general irritation and less after-scarring than a septic burn, and with none of its septic fever.

When burned or scalded surfaces are septic, the surgeon's first object will be to get rid of all dead epidermis and skin. What is already loose must be peeled off or clipped away, and charcoal poultices (see *Appendix*), and moist antiseptic dressings must be used to hasten the separation of the rest. Irrigation with antiseptic lotions must be frequent, and in some cases the use of a local bath of warm antiseptic lotion may be employed.

When granulations have well developed, their surface should be covered with protective or with a moist antiseptic dressing. The

contractions which result from extensive destruction of skin must be obviated by stretching the cicatrices when young. A little may be done by resisting contraction during healing, but generally such efforts only stop the healing process. Skin and epithelium-grafting should of course be practised in large sores.

Some surgeons are greatly in favour of oily dressings for burns. Antiseptic ointments, such as boracic, may be used, or lint soaked in a modified carron oil, *i.e.*, equal parts of lime water and 10 per cent. of eucalyptus in olive oil. The value of the 'carron' oil is probably that the lime favours the formation of an emulsion between the oil and the water, and that the evaporation of the water keeps the part cool. The escape of the water, however, tends to make the cloths stick when they are removed from the sore.

Much shock is to be expected in extensive burns, especially in children. Prognosis in such cases is grave, and stimulation is indicated from the first.

(6) **Treatment of Ulcers.** — The general indications for the treatment of ulcers are—(1) to purify the surface of the sore, and free it from irritation; (2) to stimulate the circulation of the part, if it be sluggish; (3) remove obstacles to venous return, and treat any constitutional condition that may exist.

(1) Locally, foul ulcers in the skin should be dusted with iodoform, and dressed with lint, exactly fitting the sore, soaked in antiseptic lotion, and kept moist with oiled silk, which overlaps the lint all round with a ½-inch margin.

Should granulations become œdematous, and the healing be sluggish, stimulate the surface by touching it with blue stone (sulphate of copper), or by dressing with an astringent, such as 4 grs. to the ounce of sulphate of zinc.

Bright red, "healthy" granulations should, after being washed with a stream of boracic or weak lotion, be covered with protective, over which is laid absorbent antiseptic wool, or boracic lint applied wet and allowed to dry, *in situ*.

The region of the ulcer should be kept as far as possible at rest. Thus, rest in bed is generally indicated in leg-ulcers, especially if extensive. In the case of ulcers elsewhere, fixation of the part should be carried out by a splint.

Before removing the dressing from an ulcer, the whole should be softened by soaking with lotion, to prevent any part from sticking in.

(2) *Tertiary Ulcers* of gummatous origin, are generally benefited by free blistering round the sore, in addition to other treatment.

In *Callous Ulcers* the thickened brawny condition of the surrounding parts may be got rid of by various means, all of which, however, seem to act in common by stimulating the circulation; thus, free blistering of the surface of the sore and of the surrounding skin, firmly strapping the part, or compressing it with an elastic bandage, or rubbing and kneading it once or twice daily and fomenting it with hot water, have each and all been found useful.

To strap an ulcer, strips of plaster should be cut, ½-inch wide

and 3 inches longer than the circumference of the limb. The limb should first be bandaged nearly up to the ulcerated spot, then successive pieces of plaster should be applied, beginning just below the ulcer. Apply the middle of each strip at the part of the limb opposite to the ulcer, then bring either end forwards over the ulcer to over-lap in front of it. The bandage should afterwards be continued up the limb, well above the ulcer. Should the application seem too tight, relief may be given by carefully dividing with scissors the plaster opposite the ulcer. When removing the plaster in two or three days, it must be divided at this place, and carefully pulled forwards at each side in one piece.

(3) The need for aiding venous return is almost exclusively found in ulcers of the leg, where varicose veins very frequently complicate, if they do not cause the ulcerated condition. Rest in bed in itself aids venous return, and in many cases is alone necessary for a cure. Where such confinement is impossible, support to the limb with a firm domet, or an elastic bandage will sometimes suffice. Bandaging acts probably in several ways—*i.e.*, by supporting the venous walls when they tend to dilate, by aiding lymphatic absorption, and by stimulating the tissues by the mechanical pressure.

The constitutional conditions most frequently complicating ulcers are the strumous and the tertiary syphilitic.

The strumous taint is best treated by good food, fresh air, and exercise, with cod liver oil and iron (iodide or syrup of the phosphates), and malt extract taken internally.

In tertiary syphilis, iodide of potassium (5 to 15 grs. thrice daily), is generally indicated, but in cachectic cases, a treatment more like that for "strumous" patients will be found best.

Any other general derangement complicating an ulcer, must, of course, be treated; thus the liver and bowels may require regulation, or dyspepsia call for special diet. A weak heart must be strengthened, and the system generally braced up.

(7) **Skin-Grafting.**—To further the cicatrisation of large granulating surfaces, skin-grafting may be used. In order to attain good results, it is absolutely necessary that the granulating area be healthy and a-septic. The skin from which the grafts are taken should be first purified—that of the thigh or arm is usually selected. The surgeon pinches up the skin lightly, and shaves off a superficial portion, which should include the Malpighian layer. In doing so, he just draws blood. Having in this way removed a fragment about a quarter of an inch square, he lays it on the back of his purified thumb-nail, and divides it into a dozen pieces, which are now to be laid on, raw surface downwards, at intervals over the granulating surface. The grafts and epithelial edges are next to be covered with overlapping protective, and a moist boric lint-dressing, laid over all, and secured with a bandage. The coarse superficial epidermis of the grafts speedily disappears; but in a few days a new epithelial formation sprouts from each centre.

This method has been modified by Thiersch, who, in a somewhat similar manner, grafts directly on to a raw surface. The area to be

covered is first rawed, or it may be left bare as the result of operation or accident, and a sponge is bound on it till all bleeding has ceased. Then with a razor, a large ribbon-like graft, equal in length and breadth to the razor-blade, is shaved from the anterior aspect of the patient's thigh, or other serviceable locality. This is transferred to the sore, and the process is continued till the area is covered. The extremely thin layer of skin removed leaves a surface which is bedewed with a slight ooze of blood; healing takes place with extreme rapidity, and the patient suffers no inconvenience. This operation requires the administration of an anæsthetic. The conditions should be a-septic rather than anti-septic, since the least amount of irritation gives the best result. Weak boric lotion or distilled water are the best agents.

Direct transplantation of skin gives better results than the so-called "skin-grafting." A pattern of the surface which requires covering should be drawn on the skin. The part removed should include *all* the layers, and the fat adherent to its deeper parts must be carefully removed with curved scissors. The prepared skin is now bound down under a dressing to the bare area rawed for its reception. The wound left by the removal of the skin must be purified, and drawn together with button and secondary sutures (*vide* p. 22).

More extensive methods of grafting, where a pedicle of unsevered skin maintains the vitality of the graft till it has united with its new environments, do not come within the compass of the present work.

(8) **Sinuses**, or discharging channels which refuse to finally close up, owe their existence to some local or constitutional cause. They may thus be due to a piece of necrosed tissue, bone, tendon, or gland lying deeply, to want of rest, or to a tubercular or syphilitic condition of the lining granulations. The treatment will, therefore, be to remove the dead tissue, scrape away the diseased lining, purify with antiseptics, keep the part at rest, and improve the patient's constitutional condition.

(9) **Erysipelas** and **Erythema** are, fortunately, much rarer since the introduction of antiseptics than they were a few years ago. They are still liable to appear in surgical wards, however, as patients with wounds septic, though not erysipelatous on admission, may develop erysipelas after they have been in the ward for a few days, while other patients, who have had previous attacks of the disease, are liable to have it again in their wounds, although apparently there has been no fresh infection.

It is most important to remember the extreme contagiousness of erysipelas, and to take the most rigid precautions to prevent it from spreading. No case of erysipelas should be admitted within the precincts of an ordinary surgical ward, and every patient that shows signs of the disease should at once be removed to an isolation-ward, kept specially for the purpose. The bedding should then be purified, and the bed (as well as wall and floor near it) sponged well with carbolic before it is returned to the ward.

When circumstances demand that a surgeon should dress erysipelas and other cases on the same day, the latter should be taken first, and in dealing with the former—besides attention to scrupulous cleansing and purification—the surgeon should wear a clean linen over-all, by which he protects his clothes, and so reduces to a minimum the chance of his carrying organisms away with him.

Erysipelas connected with wounds requires that the wounds be treated on general principles, especially providing for free drainage and washing out with antiseptics. The reddened surface of skin before being wrapped in cotton wool should be painted with tincture of iodine, which generally relieves the burning pain complained of. Watch must be kept for subcutaneous suppuration, and incisions made as soon as it appears. Generally milk diet is indicated. In bad cases, careful nursing and feeding at short intervals are of the utmost importance Unduly high temperature may be reduced with the ice cap, or antifibrin. Sometimes sulpho-carbolate of soda is of service, *i.e.*, 1 grain to every two years of the patient's age, given every two or three hours (*Brakenridge*). Quinine may be tried, but it often sickens. Free stimulation will be required in asthenic cases.

(10) **Whitlow** is the name given to a cellulitis which often attacks the fingers, and frequently spreads up the sheaths of the tendons to the fore-arm. When seen in the early stage, the pain and throbbing may be treated by very hot fomentation and by firm compression with cotton wool. When, in spite of this, inflammation proceeds, it should be treated by warm antiseptic applications, with early and free incisions as soon as suppuration seriously threatens. If the pus have burrowed into the fore-arm before the surgeon has been consulted, his duty will be to ensure free escape of pus and to put the fore-arm in a splint. In bad cases, irrigation or continuous immersion is indicated.

(11) **Blisters** may be considered as the result of so rapid an effusion of fluid into the superficial parts of the skin, that the epidermis is raised up by it. Frequently they are caused by mechanical irritation, such as the friction of the feet in walking, or of the hands in rowing; but they may also be formed by superficial burns, or from the application of blistering fluids, or as the result of severe bruises, or in fractures. They are frequent in erysipelas and are seldom absent in inflammatory gangrene.

Their treatment will vary with their cause. *Blistered feet* may be prevented by avoiding the too sudden beginning of long walks; by hardening the skin by bathing it in solutions of alum; by using well-fitting thick-soled boots; wearing woollen socks, and by smearing their surface with thin layers of soap, shaved off with a pen-knife, and laid on the inside of the stocking before starting for a long walk.

When blisters have formed, they should be pricked with a needle and the part protected from further irritation, if not by rest, by covering the part with protective soap plaster, or, if nothing else be available, a thin layer of soap.

Blistered toes may be wrapped with lint; but care must be taken to prevent such wrappings from working loose, and so causing more irritation than before.

Blistered hands must be treated in a similar way. Should any blister have suppurated or be much inflamed, the epidermis over it must be clipped away, and a moist antiseptic dressing applied.

Small blisters from burns or from blistering fluids should be snipped, and covered with boracic or zinc ointment, (see also *Burns*, p. 29).

The blisters of bruises or of erysipelas should be snipped, if large; dusted with powdered boracic acid, and covered with absorbent cotton-wool.

In gangrene, the blisters are forgotten in the seriousness of their cause.

CHAPTER VI.

ARREST OF HÆMORRHAGE.

Contents.—General Principles of the Arrest of Hæmorrhage—"Natural" and "Artificial" Arrest—**A. Primary Hæmorrhage**—Temporary Closure of Bleeding Vessels by the Tourniquet, Elastic Bandage, or Elastic Band—"Bloodless" Method of Operating—Various Applications of the Tourniquet—Permanent Closure of Divided Vessels by (1) Ligatures; (2) Torsion; (3) Acupressure; (4) Pressure; (5) Use of Heat and Cold, Cautery, Styptics, &c—**B. Secondary Hæmorrhage—C. Reactionary Hæmorrhage.**

General Principles of the Arrest of Hæmorrhage.

ALTHOUGH it is not within the scope of the present work to discuss points of surgical pathology, still a reference to the phenomena that have been traced in the closure of divided blood-vessels will greatly help us to understand the very various means which surgeons have devised to stop bleeding in wounds, whether it occurs at the moment of injury, or during the after-process of healing.

Stated in general terms, every method of arresting Hæmorrhage ("natural" or "artificial") involves (1) an immediate blocking of the vessel's mouth, by some mechanical obstruction not involving minute tissue changes; (2) a scaling of the end or ends of the vessel by plastic lymph, becoming afterwards (by a larger preponderance of cells and the development of capillary blood-vessels) granulation-tissue; and (3) a process of cicatrisation, by which the ends of the vessel are firmly closed by permanent and fully formed tissue.

Although, for convenience of description, these stages are separately described, it must be remembered that they pass insensibly into one another and, so to speak, over-lap. From the moment that the vessel

is wounded, and the mechanical obstruction is applied to preserve the patient's life, the vital processes which produce the second stage begin to act, and probably long before the whole mass of granulations has been fully developed, parts of it have begun to form the final cicatricial tissue. As the conditions brought about in the two later stages belong to processes which involve active changes in the tissues themselves—processes which, for want of a better word, we may call vital—it is not unnatural to expect that these two stages will be very much alike under all circumstances, and in whatever varied ways the conditions necessary to the first stage may have been brought about. And, indeed, the more accurately the processes involved in the healing of vessels are studied, the more distinctly does this come to be recognised.

Leaving aside here the discussion of the many abstruse questions included under the general terms in which the two later stages have been stated, we may return to the first stage, and see how its conditions may be carried out.

The "Natural" Arrest of Hæmorrhage.—If we confine our attention to Arteries, in the "Natural" arrest of Hæmorrhage, *i.e.*, in the cessation of bleeding which occurs when the parts are simply left to nature—the details of the process vary somewhat according to whether the vessel be cut only *partially* or *entirely* across. In the latter case, the artery contracts at the point of division, and at the same time retracts within its sheath in virtue of the state of elastic tension in which it normally lies. The blood, as it spurts from the open mouth of the vessel, deposits itself in the form of blood-clot, partly in the now empty sheath, and partly in the surrounding tissues of the wound. This clot gradually increases, forming layer by layer from the blood as it flows, until, if the vessel be a small one, say, a digital artery, the external plug so formed, in addition to the contraction of the coat, stops the bleeding. Should the vessel be a large one, say, the femoral, the current of blood will sweep away any clot that forms, and the patient will rapidly bleed to death, unless other aid be at hand to save him. Again, should the vessel be a medium-sized one, say, the radial, although the clot will be swept away at first, the rapid loss of blood will cause fainting, and during the period of enfeebled circulation which exists while the fainting lasts, a clot may have had time to form, large and firm enough to resist further bleeding when consciousness, and with it quickened circulation, returns.

After the mouth of the vessel has been closed by this external clot, a thrombus or internal clot forms inside the vessel, and, extending up within it for a variable distance, still further resists the force of the blood-stream, although it probably is not in itself quite sufficient for that purpose.

In the "*Natural*" *arrest*, therefore, when the vessel is divided across, the mechanical agent is the contraction of the vessel and the presence of an external blood-clot aided by an internal one.

Should the artery be only *partially* divided, the retracting tendency makes the wound in the vessel gape the more, so that the

outer clot has less chance of forming than if the division had been complete. Under favourable circumstances, however, the clot does form, and unless the current be so strong as to make it yield and produce a false aneurism, the processes of healing will go on as in the first case.

When an artery, instead of being cut across, is torn, twisted, or bruised across, its inner and middle coats are curled up inside the outer one, and so, by blocking the lumen, stop the bleeding; when, in addition, the outer coat is either twisted or drawn out into a fine thread, the occlusion is still more complete. Probably when the inner coat is thus injured, the internal clot or thrombus forms more strongly, and acts more efficiently in closing the vessel, than when it is divided by a clean cut.

The "Artificial" Arrest of Hæmorrhage.—In "*Torsion*" and "*Forcipressure*," therefore, whether deliberately performed by the surgeon, either directly with forceps, or indirectly by the use of the ecraseur, or cold snare, or accidentally done by the violence of machinery, the mechanical occluding agent is the twisted or torn ends of the broken vessel, aided by the formation of an internal clot.

In the use of the *Ligature*, the mechanical agent is the tight band round the tough outer coat, after the inner and middle coats have given way and have retracted. An internal clot is also formed in this case, but is not of great service in maintaining the occlusion. By the time the process of sealing up by granulations has been completed, the ligature is useless. In the old days of silk ligatures in septic wounds, the ligature, being saturated with fermenting discharges, was a source of irritation to its surrounding granulations, and became loosened by making them suppurate. If the suppurating or liquefying process went too far into the sealing mass, the vessel was opened again, and secondary hæmorrhage, formerly very common, was the result. In a-septic wounds, on the other hand, the ligature of catgut, silk, and probably of any organic material, is absorbed by the granulation cells, and disappears without any suppuration at all. The risk in these cases is the softening not of the sealing mass, but rather of the ligature, or of its slipping before the sealing mass is ready to take its place; or, on the other hand, in a large vessel, the risk lest the granulations—even when fully formed—should not have a consistence strong enough to resist the pressure of the blood-stream.

When *External Styptics* are used, the mechanical agent is probably either (1) a firmer than natural clot induced directly by the hot iron, caustic, or chemical agent, or indirectly by the altered state of the surrounding tissues; (2) an occlusion of the mouths of the vessels by shrivelling and spasm either of the surrounding parts, of the vessels themselves, or of both. When internal styptics are used, either the coagulability of the blood is increased, or a condition of temporary anæmia of the part is caused by local spasm of the arterial walls, producing a result like that occasioned by the general slackening of the circulation in fainting. One or all of these conditions may be present in the use of different agents, their exact

action, however, in the case of many known to be useful is not certain.

If we have clearly grasped the general principles involved in the above sketch, we shall the more easily be able to understand what the various kinds of hæmorrhage are, and be better prepared to apply intelligently the practical rules devised to meet them.

Three kinds of hæmorrhage have been recognised by surgeons:—1. Primary, that which occurs at the moment of division of the blood-vessel; 2. Reactionary, that which appears on the return of quickened circulation after a collapsed condition—*i.e.*, within six or eight hours of the injury; 3. Secondary, that which occurs during the process of healing of the vessel.

A. Primary Hæmorrhage.—During an operation, bleeding may be avoided by temporary pressure on the main vessels leading to the part, with subsequent closure of the wounded vessels by ligature, torsion, styptic, or cautery. In other cases, the vessels, as they are being divided, may be closed by the use of the ecraseur or cautery; or, again, the vessels may be exposed and seized with forceps before they are divided, being permanently secured immediately afterwards.

The Temporary Closure must be carried out differently in different parts of the body. In the extremities (unless when close to the trunk) the main vessel can be secured by the pressure of a tight band, applied by a tourniquet, elastic bandage, or elastic band.

(*a.*) The Tourniquet in use now is only slightly modified from the original instrument devised by Petit. The instrument is in such frequent use that a description of it would be superfluous.

The following points must be attended to in applying the band to the tourniquet:—(1) The receiving side of the buckle must be towards the limb, and about 2 inches of band must be left between the buckle and the first roller; (2) the band must pass only over the rollers of the plates, so that when the instrument is ready nothing should be seen from below but the brass margins (Fig. 9); (3) lastly, before being handed to the operator, the two plates should be screwed close together.

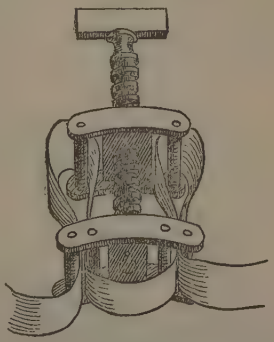


Fig. 9.—Petit's Tourniquet, to show use of Rollers.

A pad is generally used with the tourniquet, and is applied differently by different surgeons. Usually the pad, in the form of a medium-sized roll of cotton bandage, is placed over the main vessel of the limb, and over this in turn the lower screw-plate; when so applied, the pad serves the double purpose of increasing the pressure on the main artery and

preventing the skin from being nipped up as the tourniquet is tightened. Sometimes the screw and pad are moved to that part of the limb where the screw can be most conveniently reached, leaving the general compression of the band to close the artery; while, at other times, the pad is placed over the artery, but the screw moved away from it, in which case either a second pad or a bandage round the limb must be used to prevent the nipping of the skin. Any of these methods will serve the purpose; except below the knee, where the first seems best, we prefer the second method.

(*b.*) Elastic Bandage.—For the limbs of children or of thin and emaciated persons, we prefer, what Esmarch recommends, viz., a few turns of a broad elastic bandage, as it controls the vessels with less risk of injuring their walls, or of bruising nerves and muscles.

(*c.*) Elastic Band.—Esmarch has advocated the use of a strong band of elastic tubing or cord, applied while stretched once or twice round the limb. A diameter of about ¾ inch is used for the thigh, and one or two smaller sizes for the leg and arm and for the fingers respectively. The fastening for the large size is a hook at one end and several links of a chain at the other; while for the smaller sizes, some clamp, such as Foulis' catch, is generally used. This consists of a double piece of metal tubing, of diameter somewhat less than the elastic, and having a slit in one of the pieces. When the india-rubber is stretched, it can be passed into the slit; and when relaxed, its increased size makes it hold firmly in the tube. Before application one end of the elastic is held in one part of the tube, while the other end is free. A turn of bandage, to protect the skin, should be applied before the band is put on.

To apply the Elastic Band, begin at the end near the catch, and having encircled the limb with the stretched band, hold the ends together with the finger and thumb of the left hand, while the right is passed round the limb for the second pull (Fig. 10). Secure the last turn in the catch.

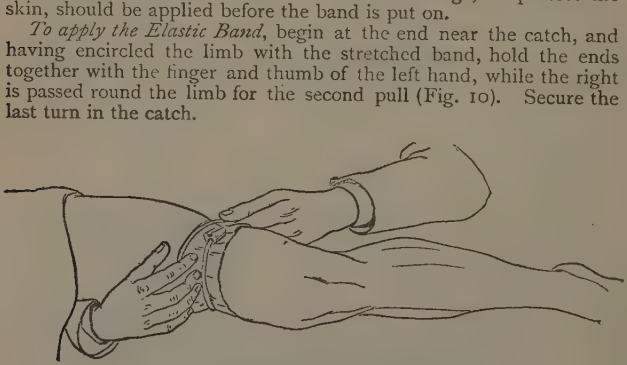


Fig. 10.—Application of Elastic Tourniquet.

The great advantage of the tourniquet (especially where there are few assistants) is the possibility of easy relaxation and tightening of which it permits. After an amputation, the main vessels can be picked up and tied; then, by relaxing the tourniquet, some previously unnoticed vessels will be found by their spouting, and secured while the tourniquet is screwed up again. The process may be repeated as often as desired.

In the interval many smaller vessels will become occluded by the blood-clot which has thus an opportunity to form. When the elastic band or bandage on the other hand is slackened, it must be removed altogether, unless, indeed, a Ward Cousin's catch be used, which can be relaxed and tightened at will.

The "Bloodless" Method of Operating.—A method, known now as the "bloodless" method, of operating was taught in Edinburgh many years ago by Professor Lister, and was afterwards independently advocated by Professor Esmarch of Kiel. The object of this method is to empty the limb of blood before the tourniquet is applied, so that the part to be operated upon may be bloodless. Professor Lister raises the limb vertically, while the patient is lying horizontally, this in itself is generally sufficient to blanch the limb in a few minutes; but the process may be hastened by compressing the main artery, and encouraging the venous return by a few passes of the hand towards the trunk. The tourniquet, or elastic band, must be applied while the limb is still vertical. Professor Esmarch produces a similar effect by bandaging the limb, from the extremity upwards, with an elastic bandage, thus forcibly driving all the fluids out of the limb. Before relaxing the bandage, he compresses the main vessels with an elastic tube, which effectually prevents the return of blood. During an operation, the "bloodless" method permits of the most perfect inspection of the part; but in proportion to the thoroughness of the process, and to the length of time it has been maintained, is the intensity of the hyperæmia which follows the return of blood. On this account, the oozing which at first occurs from innumerable small vessels is apt to cause a greater loss of blood to the patient than when the ordinary method is carried out, so that the term "bloodless," from the patient's point of view, is far from applicable. To obviate this inconvenience, as many vessels as possible should be secured before the blood is allowed to return; then a sponge should be pressed into the wound, and the limb raised for a few minutes after the circulation is allowed to return. The congestion will soon pass off, and the remaining vessels can then be picked up and secured.

Professor Lister's method is simpler, has no tendency to drive pus, blood-clot, organisms, or *débris* of a malignant growth into the general circulation, and being less complete, although sufficient for all purposes, is followed by a less intense congestion.

Special Modes of Control.—The application of an ordinary tourniquet to compress the vessels of a limb close to the trunk, or those of the trunk or head and neck themselves, is difficult or impossible. Special means are, therefore, required in particular cases:—

(*a.*) **Close to the hip-joint,** the vessels may be secured by (1) *Compression of the abdominal aorta* at its bi-furcation, either by an abdominal tourniquet, with its pad below and to the left of the umbilicus, directed backwards, and a little inwards (Fig. 11), or by a large pad on the same spot, held in position by several turns of an elastic bandage or tube (Fig. 12).

In neither of these methods need the temporary compression of the intestines be feared. The real objection is rather the hindrance to respiration, which in an enfeebled patient may seriously complicate anæsthesia.

(2) *Compression of the Common Iliac Artery* by a Davy's lever, acting through the walls of the rectum. The instrument in question is a rod of hard wood 18 inches long, and ½-inch wide at its thickest place. The end of the thicker part is well rounded off, to diminish

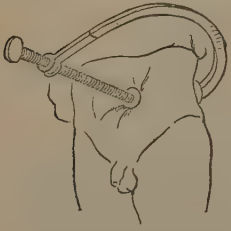


Fig. 11.—Lister's Abdominal Tourniquet.

Fig. 12.—Pad and Elastic Band compressing the Aorta.

its chance of injuring the coat of the intestine. The rectum must be emptied before the operation, and after the patient has been anæsthetised, the larger end of the lever must be carefully introduced into the rectum, and passed upwards until it reaches the posterior part of the brim of the pelvis. If the handle be then held firmly up against the pubic arch as a fulcrum, the rectal portion will be pressed down upon the common iliac artery. From the left-sided position of the rectum, the left vessels are generally easily reached; not so, however, in many cases, those on the right. In fact, unless the rectum be specially capacious, or placed rather more than normally in the middle of the pelvis, there would be a risk of injuring the gut in trying to compress the right vessels.

(3) Where the head of the femur can be left in position until the

Fig. 13.—Elastic Tourniquet applied for Amputation at the Hip-joint.

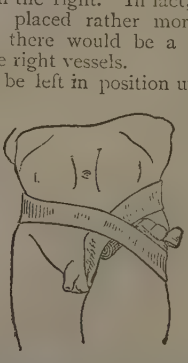


Fig. 14.—Elastic Band and Pad for Amputation at the Hip-joint.

main vessels have been secured, bleeding may be controlled by an *elastic tube encircling the thigh*, and carried round the pelvis after

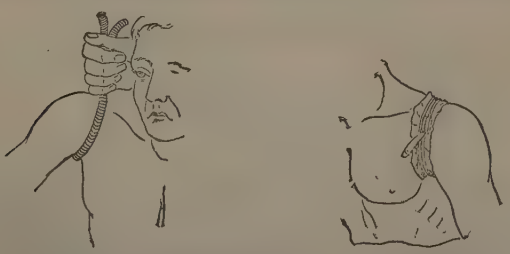
being crossed above the great trochanter. To prevent it slipping down the thigh, two supporting bands should draw it upwards at the inside—one in front, and one behind. These may be secured round the trunk or held by assistants (Fig. 13). A large pad and an elastic bandage may also be used to compress the external iliac (Fig. 14).

(4) *Digital Compression of the External Iliac* against the pubes in children, or in adults by a powerful hand, while the posterior vessels are being compressed by a pad over the sciatic notch. Most surgeons, however, prefer the security afforded by mechanical means.

(*b.*) Close to the Shoulder-Joint.—Many *operations* can be *planned*, so as to allow the main vessel to be exposed and grasped before it is divided. In other cases, the *third part of the subclavian* may be *compressed* against the first rib by a firm pad pressed downwards from above the clavicle by an assistant (Fig. 15). For this purpose, an india-rubber tipped compressor has been devised, but the handle of a door-key or other similar instrument, well padded, acts nearly as well. When the greatest security is desired, Mr. Syme's plan should be followed. In a case of axillary aneurism, the *skin above the clavicle was incised*, and the cellular tissue separated to allow an assistant's fingers to reach the artery itself, and hold it against the first rib. Sometimes the axillary artery can be controlled by elastic tubing (Figs. 16, 17).

Fig. 15.—Compression of Subclavian with Compressor.

In the *neck*, the *common carotid* may be temporarily compressed against the cervical vertebræ, by inserting the fingers beneath the sterno-mastoid and pressing directly backwards. The "carotid" tubercle—*i.e.*, the transverse process of the fifth cervical vertebra, is



Figs. 16 and 17.—Elastic Tourniquet compressing Axillary Artery.

the best position to take; but the operation is always a painful one. Owing to the freedom of anastomosis across the middle line, not

much is to be expected from compression of the vessels of the face or scalp. Still, the *facial arteries* may be held against the lower jaw, just in front of the masseter; the *temporal arteries*, against the sides of the frontal bone, or upon the zygoma, just in front of the ear; and the *occipital arteries*, against the occipital bone between the external occipital protuberance and the mastoid process. The *coronaries* of the lip can be easily controlled by the grasp of an assistant's fingers, or by special forceps for the purpose.

The *lingual arteries* may be compressed, as Mr. Christopher Heath advises, by passing the fore-finger behind the tongue, and hooking the soft parts forwards and inwards against the lower jaw. This may often be useful in an emergency.

Even where feasible, it would be impossible to apply any of the above means of stopping bleeding for longer than an hour or two at the most, lest the tissues should be so starved by want of nourishment, that they would inflame or become gangrenous when the blood returned.

Permanent Closure of Divided Vessels.—The means at our disposal of immediately closing divided vessels are many:—

(1) **Ligatures.**—The mouth of the artery or large vein, being grasped with forceps, is slightly drawn out from its sheath, and secured by a ligature. Formerly, a curved needle on a handle or tenaculum was passed into or near the vessel, so that it might be raised; afterwards, sharp-pointed forceps were adopted with a catch to keep them shut (Fig. 18), these being subsequently

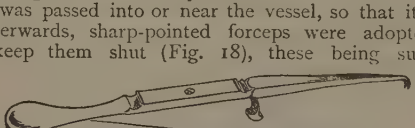


Fig. 18.—Artery Forceps (sharp pointed).

improved, so as to make the thread slip better over their end (Fig. 19); while, more recently, pressure forceps have been

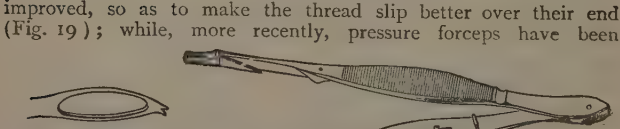


Fig. 19.—Fenestrated Artery Forceps; Torsion Forceps.

introduced, of which there are many modifications. The best are, perhaps, the strong conical-ended forceps, known as "Wells' forceps," from their having been modified by Sir Spencer Wells; although many similar instruments, such as Péan's (Fig. 20), Tait's, or Kœberle's original, are nearly as good.

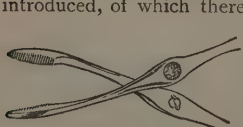


Fig. 20.—Péan's Forceps.

During the progress of an operation, the mouths of bleeding vessels can be secured as they are divided, or just before it, if the vessels can be seen, and the surgeon may proceed with his work, leaving, perhaps, ten or twelve pairs of forceps hanging on to the surface of the wound. In a few minutes he may return to the forceps, and find, after tying the larger vessels, that the squeezing of the smaller ones has completely closed them.

Tying of Arteries.—In tying the arteries, the forceps should be drawn by an assistant, obliquely away from the person who ties, as soon as the ligature has been passed round the artery (Fig. 21). As the first knot is being tightened, the handle of the forceps should be lowered more and more on the side away from the knot, to lessen the risk of including their points. On the knot side, the operator's forefingers ensure that the thread passes well over the forceps. When the thread, thus guided on to the soft parts alone, is being firmly drawn, the forceps must be slipped off, so as to allow of additional tightening. The second knot may then be made,

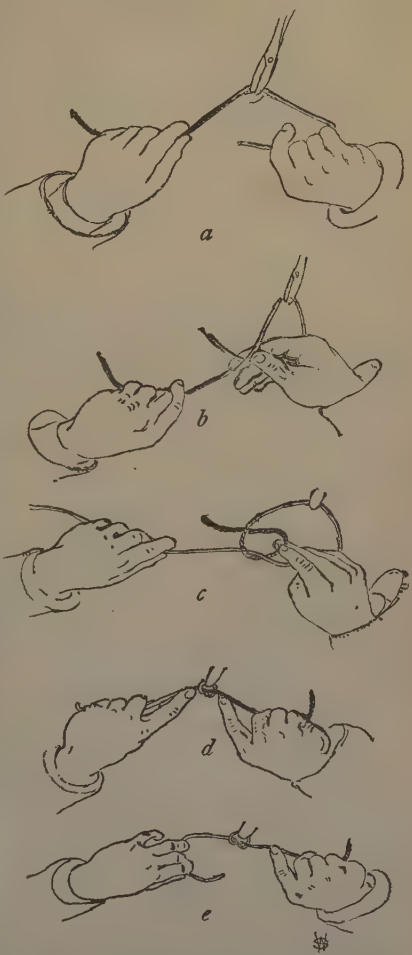


Fig. 21.—Tying the Reef-Knot, first method.

and a third, if necessary. Although a single turn is generally sufficient, a double turn, although more difficult to tighten, lessens the risk of slipping before the second knot is made, and may sometimes be needed. From time immemorial, the reef-knot has been advocated as imperative lest the thread should slip, and it ill becomes us to discredit this practice. We shall only say, however, that sailors prefer the "reef"-knot (Fig. 22) to the "granny" (Fig. 23), less because the former is more secure, than because it

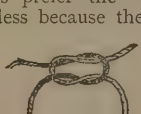


Fig. 22.—The Reef-Knot.

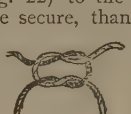


Fig. 23.—The Granny.

can be pushed out and undone more easily. The difference between the two knots is in the second twist. If each end, after being twisted round the other once, be brought back on itself past the other before being twisted a second time, the "reef" will be formed. If they be crossed over at once, the "granny" will be the result.

Two simple ways of ensuring the constant formation of a reef-knot will be easily seen from the diagrams (Figs. 21 and 24).

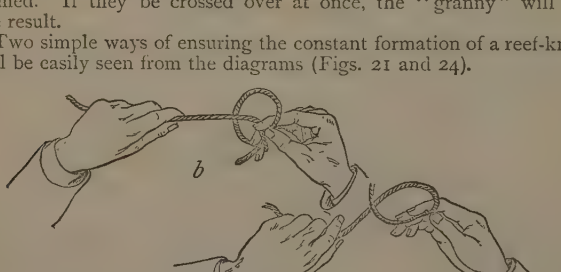


Fig. 24.—Tying the Reef-Knot, second method.

In both series the operator is supposed to be looking at his own hands. The difference in the two methods lies in the first stage of the knot. In the first one, the twist is given by the right hand; in the second, it is done with the left. One half only of the knot is shewn in each case. To complete it, a similar procedure must be carried out with the opposite hand.

When working in a cavity, the ligature must be firmly held by the third and fourth fingers, while it is guided by the forefingers over the forceps. When the knot is tightened, the forefingers are to be used as pulleys, to make the strain transverse, and so prevent the knot from being pulled off the vessel (Fig. 21 *d*).

The ligature should be a foot long, to permit of this firm grasp.

It is not necessary to tie the smaller vessels on the face of an easily accessible wound with the same care as a main vessel, or a smaller one in a cavity. Dr. Joseph Bell employs a long ligature, which he holds in his left hand, and uses repeatedly, saving both time and ligature. In practice the method answers well. In drawing on the first twist, the hands should be crossed,* and the thumb of the right hand used like the forefinger to guide the thread. This in an open wound is no objection. The crossing is required, because the ends do not change hands as in the ordinary way, the single long end remaining coiled up in the left hand, or twisted round the left little finger.

Facility in tying arteries is an important accomplishment, and saves much time in an operation. Every young surgeon should practise the art with string on a piece of cloth, until he can do it without effort—reflexly, or in the dark. When a large artery is tied in its continuity, the knot must be a "reef," firmly and securely fastened with, perhaps, two or three extra twists.

For different materials used as ligatures, see *Appendix*.

(2) Torsion.—For the smaller vessels, all that requires to be done is to seize the open mouth with pressure forceps (Fig. 19), or special torsion forceps (Fig. 20); draw it out a little, and twist it four or five times round—some say, until it breaks off, but this is not necessary. Larger vessels must be steadied after being drawn out by one pair of forceps, while they are twisted three or four times round with another pair.

Experience has shown that torsion is a perfectly safe method of closing even the largest vessels. However, for large vessels anywhere, and for smaller ones, unless when lying in unusually lax tissues (as in the scrotum, or beneath the mucous membrane of the rectum), ligature under antiseptic precautions with absorbable material, is equally efficient and more rapid, as obviating the need for so carefully isolating the vessel.

A modification of torsion is forcible pulling out. Victor Horsley, in excising the thyroid gland of monkeys, seized the arteries, and drew them out from the gland, until they tore away. The broken vessels were in this way simultaneously divided and closed, and gave no further trouble. Under certain circumstances, this method might be useful.

(3) Acupressure has now fallen almost entirely into disuse. It was introduced by the late Sir J. Y. Simpson to obviate the irritation of silk threads in a decomposing wound, which only conducted the septic mischief closer to the wounded and healing artery.

One of the methods employed may be sometimes useful on the scalp, or in the face, where there is difficulty in finding the wounded vessel, and where further cutting is undesirable. This method consists in passing below the vessel, at a little distance from the wound, a needle, round whose projecting ends a loop of wire or silk is afterwards wound, so that the artery is compressed between the needle and the silk.

* Even if the hands be not crossed the first time, the knot will be drawn properly the second time.

(4) **Pressure** directly over the wounded vessel will stop the bleeding in any artery, although, owing to the simultaneous pressure upon companion-veins and on other structures, the method is inconvenient. Wounds of any of the palmar arteries are frequently treated by graduated pressure, although general pressure often succeeds as well. The arteries of the palm are difficult to reach, and lie close to large nerves; moreover large cicatrices are undesirable there, hence the need for pressure. *Graduated pressure* is produced by a series of successively larger pads of lint, beginning with one that just fits into the wound, until a conical plug is formed. This, when bandaged in place, presses upon the wounded part, and generally stops the bleeding. At the same time the circulation in the hand should be lessened, by firmly bandaging the forearm, by placing pads over the radial and ulnar arteries at the wrist, by flexion of the forearm, and by raising the hand by fixing it at the opposite shoulder.

The pads used in the wound should be soaked in antiseptic lotion. They should be removed in 24 or 36 hours, and equable pressure over the wound be substituted. When possible a firm flat pad over the wound should be used from the beginning, as it permits of closure of the wound, and if successful, obviates the risk of an outbreak of the bleeding, such as may occur when the graduated pad is removed.

All that has been said of the palm of the hand applies equally, with the necessary modifications, to the sole of the foot.

(5) **Use of Heat and Cold.**—As the result of recent experiments on the vessels and muscular tissue of the uterus of rabbits, Milne Murray has shown * that—

"(1) Water, at temperatures of 120° F. and 10° lower, contracts blood-vessels, and arrests hæmorrhage from small arteries.

"(2) Water, at temperatures of 100° and 30° or 40° under, dilates small vessels, and promotes hæmorrhage.

"(3) Water, at temperatures of 50° F. and 20° under, checks hæmorrhage by constricting blood-vessels, but this only temporarily.

"(4) After water at the above temperatures has lost its styptic power, water at high temperatures is still effective."

These experiments have been fully verified by clinical experience in postpartum hæmorrhage.

The more efficient and lasting effects produced by hot water, *i.e.*, at temperatures between 110° and 120° F., as well as the diminished risk of its inducing shock by abstracting heat, would lead surgeons to employ it in many cases where formerly cold was used. In bleeding from inaccessible cavities or deep wounds, for instance, the injection of hot water, preferably medicated, has been found of great service. Hot water has also the advantages of being generally more readily available than very cold, and, after it has been boiled, of being at least a-septic. The observations hitherto have been made chiefly directly on wounded surfaces and upon bleeding mucous

* *Ed. Med. Journal*, Sept., 1886.

membranes, which seem to stand without damage a temperature which would blister the skin. If we have to produce constriction of vessels at a distance below the skin by the continued action of either heat or cold, we should prefer the latter. It would be more difficult to maintain the constricting high temperature on the deep parts, and, if it were maintained, its effects on the intervening tissues would be serious.

When temperatures from 120° to the boiling-point and onwards are brought to bear on the tissues, effects other than those produced merely by muscular spasm are seen. There is (besides injury visible only by its results) first coagulation of albuminous substances and softening of connective tissue; a higher temperature still more coagulates the one and hardens the other; while the temperature of dull red-hot iron coagulates and hardens all tissues, and kills them at the same time.

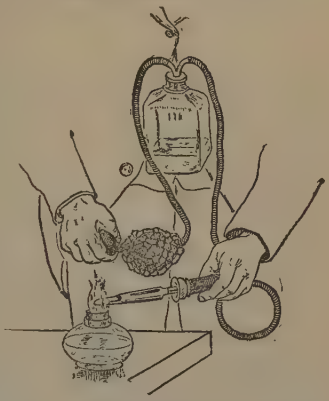


Fig. 25.—Pacquelin's Cautery. Heating the Knife before pumping in Benzoline vapour.

Cautery.—The actual cautery is thus a most powerful styptic, as it, when properly applied, shrivels up all the tissues into a hard mass. The greater the heat, the more rapid and the more superficial its effect; so that if a blunt-edged blade be used white-hot, the vessels bleed nearly as much as if they had been cut across with a sharp knife; while if a dull-red or black heat be employed, the progress is slower, but the shrivelling and occlusion of vessels complete.

Pacquelin's thermo-cautery is used where vascular textures not easily accessible have to be divided (Fig. 25). It is also of service in searing the skin, or otherwise, where the actual cautery is required. In using this instrument, the knife must be thoroughly heated in the spirit-lamp before the benzine vapour is blown in, otherwise the knife is only cooled by the cold blast.

The galvano-cautery is employed for cutting through the vascular base of polypoid growths, where direct access to the divided vessels is impossible, or in the removal of a fibrous polypus from the naso-pharynx. From what has been already said, the advantage of using the wire at a dull-red heat will be apparent, but this has been found somewhat difficult in practice to regulate.

Cold.—From almost time immemorial, cold has been used to check bleeding, and there is not the slightest doubt that cold does constrict blood-vessels. The effects of prolonged cold in producing pallor of the skin is well-known, and probably was the clue that first led to

its application to bleeding. Milne Murray's experiments seem to indicate that the direct application of cold to bleeding parts induces a constriction at first, which rapidly passes off; but since prolonged cold to the extremities seems undoubtedly to maintain pallor, it is probable that some of the special effects of cold upon the skin depend upon its action through the nervous system.

When a lowered temperature is desired, we rely on two methods of obtaining it—*ice*, for direct and indirect effects, and *evaporation*, for indirect effects only. The former may be applied in an ice-bag, one third filled with small pieces, or it may be used to cool water which is then circulated in Leiter's tubes, or dripped by irrigation over the part, or, if more convenient, a cloth may be wrung out of it and laid over the part. Should cold injections be required, the ice may be put in the water or lotion.

The great physical fact, that evaporation requires heat, and that fluids will abstract the heat they want from surrounding parts, in order to evaporate, is often turned to account when a low temperature is wanted—*e.g.*, a wet cloth laid over the skin, and allowed to evaporate, will chill the part it lies on, hence the risk of wet clothes. If fluids which evaporate more quickly than water be used, the cold will be so much the greater; hence the use of alcohol and solutions of carbonate of ammonia in evaporating lotions (see *Appendix*). One of the most volatile of available fluids is ether. When the evaporation of this is hastened by a blast of air, the freezing-point is easily reached.

Cold, as a hæmostatic, is chiefly recommended for hæmorrhage in internal organs at some distance below the surface – such as in suspected hæmorrhage from the brain. The cold must be so applied as to effect the constriction of the vessels of the affected part, or that of the main vessels leading to it. Its application must be continuous, but not sufficiently so as to lower vitality to any appreciable extent; hence the need of care in its use.

Formerly, cold injections were used for bleeding mucous membranes and for deep oozing wounds; but where a fluid at a temperature of about 110° can be brought to bear upon them, we should advocate its use instead.

Application of Styptics.—Of the many styptic agents which have been employed, it is only necessary for us to explain the use of a few. No matter what the styptic is, it should always be applied directly to the mouths of the cut vessels, without any intervening blood or blood-clot. After clipping off large venereal warts from the penis, for instance, before the temporary elastic or other constriction is released from the body of the organ, the raw surface should be well painted with perchloride of iron, and when the blood is allowed to return, scarcely a drop will escape. Of course, we may wish to apply styptics while bleeding is still going on. Then we must do our best to first sponge the surface clean and remove all the clots which have collected in the wound. A styptic, when mixed with blood on the surface of a wound, only makes a cloggy mass, which,

while not stopping the bleeding point, hides it from subsequent attempts.

Various Styptics.—Powdered alum, matico leaves, and also cobwebs are recommended as styptics, but are not often used.

(*a.*) *Turpentine*, soaked in a cloth which plugs a deep oozing wound, acts well. This may be called a domestic remedy, and is an antiseptic as well as styptic. It is less irritating to the tissues than perchloride of iron. Some hold that the plugs in which it is soaked should be removed at the end of a few hours; but it is doubtful if any further irritating effect is produced after this time.

(*b.*) *Tincture of Perchloride of Iron* is one of the most efficient styptics in use, but it is, at the same time, one of the most irritating to the tissues, and its application is generally followed by more or less sloughing. It makes a hard sticky mixture with blood-clot, of a dark colour, and unless applied, as above stated, directly to the raw surface, it does more harm than good. It should only be used when unavoidable. It may be painted on the wound surface, soaked in the texture of a plug, or injected into a cavity.

(*c.*) *Hazeline*, or the active principle of Witch Hazel (*Hamamelis virginica*), has during the last few years been advocated as an astringent and hæmostatic. Locally, it may be applied as an ointment, by injection, painting, or on a plug.

(*d.*) *Gallic and Tannic Acids*, applied as powder or in solution, have long been advocated as local and remote styptics, as well as astringents. Recently, Stockman,* after having carefully and thoroughly investigated their action, has concluded that we may lay aside gallic acid, at least, since its only action is the slight local one of a weak acid. On the other hand, he shows that tannic acid, when applied locally, precipitates albumen and may thus be of service for discharging surfaces, but that other agents are preferable for primary hæmorrhages. "As a remote astringent it is valueless."

In addition to the above, most of the antiseptic agents in common use, such as solutions of carbolic acid, corrosive sublimate, chloride of zinc, tend to check capillary oozing in proportion to their strength, aided also by the temperature at which they are applied.

(*e.*) *Caustic Agents*, especially strong acids, act also as styptics by coagulating the blood and attacking the mouths of the vessels. Of these, nitrate of silver may be selected to stop the bleeding from leech bites, and strong nitric acid is useful for the bleeding which comes from sloughing phagadena, as it checks the disease as well as the bleeding.

Other Means.—Besides local applications, other ways of inducing arrest of hæmorrhage are available. The general circulation can be kept quiet by the horizontal position, low diet, abstinence from stimulants, or hot fluids which excite the heart, and freedom from mental excitement; functional rest can be aimed at for the affected part, and certain drugs can be administered, which experience has proved to be of service. Ergot, given by the mouth, or injected

* *British Medical Journal*, December, 1886.

subcutaneously, seems to act on the vessels of other organs besides those of the uterus, probably by causing spasm of the muscular walls of small arteries. Turpentine, in 3 min. doses, given with mucilage, and repeated every two hours, is certainly of service in bleeding from the lung in phthisis. It might therefore be expected to be of use in wounds of the lung, and probably in other forms of internal hæmorrhage as well. Tincture of hazeline in 5-10 min. doses is also strongly recommended. Other agents have been recommended, but the evidence in their favour is doubtful.

(B.) **Secondary Hæmorrhage** differs practically from Primary Hæmorrhage in this, that the bleeding comes from vessels whose mouths are softened by granulation, and are therefore incapable of holding a ligature, the surface of the wound being also obscured by granulations, so that the individual textures cannot be distinguished. This bleeding is almost invariably from a septic and suppurating wound, and may set in at any period while the suppuration is going on. When silk ligatures were used in septic wounds, Secondary hæmorrhage was most common at the separation of the ligature about the third or fourth day; but it might appear at any time, if the ulceration extended to the coats of any large vessel. The worst feature of Secondary hæmorrhage is—the uncertainty of its onset. It often comes on while the patient is asleep, without disturbing him in the least, often while he is improving in health, and when the wound, except for a slight suppuration, seems rapidly healing. On this account, wounds suppurating near large vessels, (especially if recently ligatured), must be watched with the greatest care. No foreign body should be allowed to press upon the wall of a large vessel, especially not on an artery. The effect of the resistance of the blood within the vessel and the pressure, however gentle, of the foreign body outside of it, is nearly certain to lead to ulceration through the coats. On no account, for instance, should a drainage-tube be allowed to press upon the sheath of a large artery. Lives and limbs have been lost by the faulty position of a drainage-tube before now.

As soon as Secondary hæmorrhage is discovered, check it by pressure, if possible, upon the main artery leading to the part. Next, after assistance has been called, find out by the colour of the blood and nature of its flow, if it seem arterial or venous—remembering, however, that often in Secondary hæmorrhage the flow from an artery is continuous, and not intermittent, since the blood may escape from a small hole, and flow through blood-clots and granulations. Often when the first compression is released, the bleeding has ceased—only to return, however, in a few days or hours, when the circulation has improved and the ulceration again made way.

Should the bleeding have ceased when the means of stopping it are at hand, precaution against its return should be adopted. The circulation in the part must be diminished by posture, and functional rest; deep clots should be left undisturbed, superficial ones removed; the wound may be cleansed with antiseptic lotions, and a pad placed over the bleeding spot. In a limb, a tourniquet may be left

loosely in place, and special watch be kept against the risk of fresh bleeding, while at the same time the general indications as above are carried out.

Should bleeding break out at any time in a smart stream and resist moderate pressure, elevation of the limb, and rest, an effort should be made to detect its source. If from a large artery, and if graduated pressure with styptics fail or seem unadvisable, the only resources are ligature of the main trunk higher up or amputation. If it be from a large vein, localised pressure is generally sufficient, aided by styptics, and by the removal of all obstacles to the venous return.

If the bleeding should be in the form of a general capillary ooze, the limb must be raised, and the part injected with a hot antiseptic lotion, or swabbed out with turpentine or hazeline, after which a dressing with firm pressure should be applied, and the general circulation kept down. Plugging is not generally required.

(C.) **Reactionary Hæmorrhage** occurs a few hours after a recent wound, on the return of strong blood pressure after a condition of shock. Blood-clots are pushed from the mouths of vessels, but remain in the wound as a kind of poultice, which encourages vascular dilation. To check this form of bleeding, the wound should be exposed, and the amount of bleeding noted. Sometimes cold or hot antiseptic injections will suffice. If not, the wound must be opened up, and the clots removed. Should this fail, the bleeding point or points must be found, and secured with a ligature. Where no single point can be seen, and if the above measures have failed, reactionary oozing must be treated like secondary capillary oozing. General oozing may be expected in hæmophilic patients, and in parts congested either from previous inflammation or from undue prolongation of the "bloodless" method.

CHAPTER VII.

ARREST OF HÆMORRHAGE (*Continued.*)

Contents.—Treatment of Bleeding from Special Parts.—Bone; Fibrous Textures; Deep Cavities—From the Nose; Rectum; after Lithotomy; from Varicose Veins; the Prostate; the Bladder; the Kidney; the Mouth; the Tonsil; the Palmar Arch—Hæmophilia—Digital Compression of the Main Arteries—**Transfusion**—(*a.*) Of Water or Saline Solution—(*b.*) Of Blood.

Bleeding from Special Parts.

THE various rules which are given for stopping bleeding after particular operations, are based—not on any difference in the processes of healing of vessels in different parts—but upon the differences in their position, and therefore in their accessibility, in the nature of

the surrounding tissues, and in the functions of the part in which they lie.

(*a.*) *Bleeding from bone* may be troublesome, because the vessels have less muscle than usual in their walls, and, besides, cannot easily contract on account of their hard surroundings. Moreover, the hard, dense surrounding bone prevents the application of a ligature. If the vessel be a fairly large one, such as the inferior dental, a wooden plug should be pushed into its canal for a few minutes. In most cases, firm plugging is sufficient, and acts well, because the surrounding parts are so resistant. To prevent the plugs from sticking into the wound, they may be soaked in glycerine, or oil (preferably eucalyptus), or they may be forced into a piece of oil-silk previously placed in the cavity. The best plug is a long narrow strip of lint or gauze, tucked in upon itself into the cavity. The end or ends must be left out for convenience in withdrawing. It is not generally necessary to leave the plugs in for more than twenty-four hours.

(*b.*) *Bleeding from firm fibrous textures* resembles that from bone. Such textures are the firm subcutaneous tissues of the scalp, or connective tissue in any other part of the body matted by chronic inflammation, or that found in a fibrous or fibroid tumour. Here also the mouths of the vessels remain open, and cannot easily be tied, but compression or plugging is effective if the region is accessible. If the bleeding vessel can be reached behind the *bleeding*

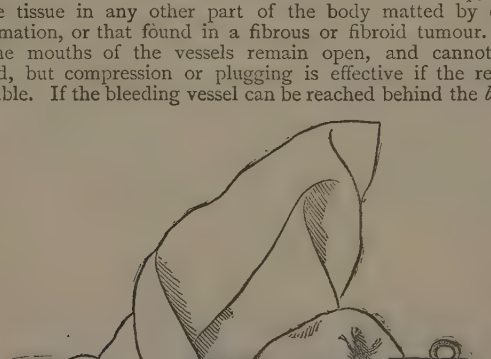


Fig. 26.—Lithotomy Tube, with Plugging.

point, it may be controlled by the pressure of the pad or compressed by an acupuncture needle, third method. Styptics, and especially the actual cautery, may sometimes be applied to the bleeding point.

(*c.*) In *bleeding from deep cavities*, besides hot (or cold) and astringent injections, the principle of *tampooning* may be carried out.

This consists essentially in introducing a *rigid* tube to permit of drainage or maintain patency, and packing round about it. The simplest way to do this is to tie a piece of lint or oil-silk round the deep end of the tube, to form a petticoat, and to distend this with plugs, as has long been practised for bleeding after lithotomy (Fig. 26). Another way is to adapt outside of the tube a distensible india-rubber bag, which can be inflated at will. On this principle depend Trendelenberg's Tracheotomy Tampoon, Buckstone Brown's lithotomy tube, and similar devices suggested for the nostril and rectum. After these general remarks, a few directions may be necessary for special forms of hæmorrhage.

(1) *Bleeding from the nose*, or epistaxis, is sometimes extremely troublesome. The patient should stand erect—*not stoop*—bathe the face and neck with cold water, and draw air gently through the affected nostril. Raising the arms above the head helps to lessen the circulation in the head and neck. Hot injections should next be tried, then swabbing out with hazeline or some of the milder styptic colloids, plugging the anterior nares afterwards, then plugging also the posterior nares. If this fail, the cavity of the nostril may be packed with a long strip of lint, either soaked in some styptic, or dry. We do not advise the injection of perchloride of iron, as it irritates the mucous membrane so much. Sometimes great benefit

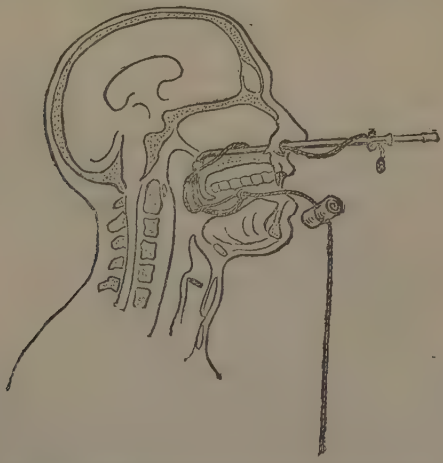


Fig. 27.—Belloc's Sound. Plugging the Posterior Nares.

results from freely opening the bowels with a large enema or smart purge.

To plug the posterior nares, pass a stout silk thread from the

nostril round the soft palate and out at the mouth. To the centre of this, loop a pledget of lint, about the size of the last joint of the patient's thumb, and draw it by the nose-thread into the mouth; work it past the soft palate, with the finger if necessary, and draw it into the posterior nares. The thread in the nose and that in the mouth are then to be tied together over a pad of lint to prevent the thread from cutting.

For passing the thread through the nostril, a Belloc's sound may be used; but an equally good way is to make the silk fast to the end of a gum elastic catheter, which can be easily passed from the nostril into the pharynx; when there either it or the thread may be drawn with forceps through the mouth. As soon as the silk is secured, the catheter may be withdrawn (Fig. 27).

In bad cases, the posterior plug may be left in position for twenty-four to thirty-six hours, then it should be carefully withdrawn by the thread left in the mouth.

(2) *Troublesome bleeding from the rectum* may occur from ulceration into varicose veins, or may follow the removal of internal piles. It may be either arterial, venous, or capillary, and is difficult to stop—chiefly because the sphincter prevents ready access to the bleeding point. Should the bleeding continue after the removal of clots and injection of hot water, apply cocaine and use a speculum. If the vessel can be seen, it may be stopped by the application of a strong styptic. Should this fail, give chloroform; stretch the sphincter, and pull down the affected mucous membrane; search for the bleeding point and tie it. Digital pressure may be employed; this was kept up by Syme for several hours in a case where he had cut off an internal pile (before he had taken to the ligature). When surgeons used simply to cut off internal piles without further precaution, bleeding was common, and often fatal. Now bleeding is stopped by tying or crushing the base of the pile, or by cauterising the cut surface. When other means fail, the rectum may be plugged with a tampoon, care being taken to avoid over-stretching of the sphincter.

(3) *Bleeding after Lithotomy* may be from the veins of the prostate, or some perineal vessel, which, if visible, should be tied. If hot injections and raising the pelvis fail, use a tube and a petticoat, or a Brown's tampoon.

(4) *Bleeding from the Prostate* may come on in old men, apart from any operation. It is then probably from varicose veins. The bowels should be opened, and the patient kept recumbent with the pelvis raised. Ergot may be administered internally, and the bladder washed out with hazeline solution. When other means have failed, relief has been given by incising the prostate by the lateral operation.

(5) *Bleeding from Varicose Veins.*—Excessive hæmorrhage follows the rupture of varicose veins in the lower extremities. The enlarged veins are frequently buried in brawny, infiltrated, inflamed tissues; but sometimes traverse the base of an ulcer, which may be insignificant in size and appearance. When the wall of the vein

gives way, a great gush of dark blood takes place. It ceases as soon as the patient lies down, and holds his leg vertically upwards. Even while he is erect very slight pressure, if accurately applied, as by means of a dossil of lint and a bandage, at once arrests the flow.

(6) *Bleeding from the Bladder*, when troublesome, is almost invariably from a tumour. No effectual cure can be expected short of removing the tumour, but the bleeding may sometimes be diminished by complete rest, internal styptics, and injections. Thomson advocates the injection of nitrate of silver, ·1 gr. to the ounce, gradually increased to 1 gr. to the ounce, or perchloride of iron, 30 min. to ʒi. to water ʒiv. Hazeline or ergot internally may be given at the same time.

(7) *Bleeding from the Kidney*, when extensive, may be the result of injury, or of an operation upon or near the kidney, or it may arise from a tumour-growth. No direct application can, of course, be made to the kidney, unless there is an open wound. The patient must be kept at rest, and on milk-diet. Ergot or hazeline may be tried internally. The bowels must be kept relaxed to prevent irritation from hardened fæces. Pain is to be subdued by morphia. Sickness, when it threatens to appear, is avoided by simple and sparing diet.

(8) *Bleeding from the Mouth* is commonly from the tongue, secondary to some operation. In an emergency, the lingual artery may be compressed, and at the same time brought forwards by the finger, passed back to the epiglottis, and then hooked forwards so as to bring the soft parts with it (*Heath*). If the wound be recent, the artery may be secured with forceps and tied; if not, the part must be plugged, with styptics, if need be. Should bleeding recur, the lingual artery may require to be tied—either in the submaxillary triangle, or just behind the great cornu of the hyoid bone.

(9) *Bleeding from the Tonsil* sometimes occurs after tonsilotomy, and generally comes from an unusual or enlarged branch of the ascending pharyngeal artery. Whether the operation has been done with the tonsilotome or with the knife, if the abnormal artery be there, it will bleed when cut. From the position of the bleeding point, a ligature is very difficult to apply to it. Digital pressure maintained for some minutes, or the pressure of a hot sponge, may be enough. Should these measures fail, clear away all clots, and apply styptic pads, holding them in position for from five to ten minutes; and if this be insufficient, the point of an actual cautery will be needed. In a few cases, ligature of the common carotid has been required; but in spite of even this, death has sometimes ensued. Fortunately, however, the bleeding after tonsilotomy is generally slight, and ceases spontaneously in a few minutes. It is worthy of note that in at least three recorded cases, previously serious bleeding ceased after a fit of vomiting, whether spontaneously or artificially induced.

(10) *Bleeding from the Palmar Arch* has been already alluded to. The reason for the difficulty is, that in the palm, the superficial

arch is covered by strong fascia, and lies near large nerves. Free dissection is also prevented by the after-inconvenience of large cicatrices. The deep arch is out of reach. If a limited dissection give small hope of success, apply firm pressure—possibly graduated—with antiseptic precautions. At the same time restrain the circulation in the hand by the methods already indicated (p. 46). Should these measures fail, ligature of the brachial artery would be the next step.

Hæmophilia.—The above indications have been made on the assumption that the patient's tendency to spontaneous healing of vessels has been normal. There exists, however, a condition, fortunately rare, where patients bleed long and freely on the slightest provocation. The disease is known as "Hæmophilia," and the patients as "Hæmophilics" or "bleeders." The nature of the malady is obscure. The vessels seem normal, and out of the body the blood is said to coagulate well. Whether it does so equally well within the body has not yet been proved, but seems doubtful.

Hæmophilia is often hereditary, and is probably often present in degrees. In bad cases, a slight pinch of the skin will be followed by extensive ecchymosis, and smaller cuts by continuous oozing. In dealing with such patients, reliance must chiefly be placed upon pressure and styptics.

Digital Compression of the Main Arteries.

Subclavian (*third part*).—Against the first rib by pressure downwards and backwards, just behind the anterior curve of the clavicle.

Axillary (*third part*).—Against the humerus by pressure directly outwards, at junction of anterior and middle thirds of the axilla.

Brachial.—Against the humerus. The pressure must be outwards at the upper part, outwards and backwards about the middle, and backwards at the bend of the elbow, to suit the altering relations of the bone and artery. The artery continues the line of the axillary to the middle of the bend of the elbow.

Radial and Ulnar Arteries.—At the wrist, pressure backwards at either side.

External Iliac.—By pressure directly backwards against the brim of the pelvis, midway between the symphysis pubis and the anterior superior spine.

Femoral.—Pressure must be made at first backwards against the head of the femur, then backwards and outwards in Scarpa's triangle—in Hunter's canal, outwards. When viewed from the inside, *i.e.*, in abduction, the line of the vessel continues that of the external iliac towards the adductor tubercle on the inner condyle of the femur: looked at from the front, the line runs toward the inner edge of the patella. The first point mentioned for pressure is the best (see chapter on *Extempore Appliances*).

Anterior Tibial.—Midway between the two malleoli, backwards against the tibia.

Dorsal Artery of the foot.—Downward pressure against the tarsus between the mid-point of the malleoli and the interval between the first and second metatarsal bones.

Posterior Tibial.—Forward and outward pressure against the tibia, a thumb's-breadth from the internal malleolus.

Transfusion.

The methods of injecting fluid directly into the veins of persons who are greatly reduced by loss of blood or wasting disease, have been, in recent times, revived and much discussed. The objects to be attained by such proceeding are these: either (1) To add fluid to the circulation, and so give the heart something on which to contract; thus to enable it to utilise the blood which always remains in the veins after bleeding, and to stimulate absorption (water or saline fluids); (2) to add also nutriment to the blood (blood or milk); or (3) to add to it, besides fluid and nutriment, red blood-corpuscles, which will be functionally active as respiratory agents (blood).

Of these, while the second is of doubtful value, and the third of doubtful possibility, the first is unquestionably possible, and is often all that is required to save life, especially after sudden hæmorrhage. The effect produced has been called the "*dynamic*" effect. A-septic (boiled) water at blood-heat, injected to the amount of about 1½ litre (2¾ pints) has been found sufficient in an apparently desperate case of post partum hæmorrhage. A warm ¾ per cent. solution of common salt in distilled water would be preferable to plain boiled tap water. Various other saline solutions have also been recommended; but it would be difficult to prove their practical advantage over either water or a ¾ per cent. solution of common salt. Jennings advises the following:—

Chloride of Sodium, 50 grs.	Chloride of Potassium, 3 grs.
Sulphate of Soda, 2·5 grs.	Carbonate of Soda, 2·5 grs.

Phosphate of Soda, 2 grs.

Dissolve in 20 oz. water at 100° F., and add 2 drachms of absolute alcohol.

The great desideratum is simplicity of material and apparatus. In all cases of danger from sudden loss of blood, it is well to remember the great possible value of 15 or 20 ounces of boiled (a-septic) water at 100° F., with or without saline addition.

Apparatus Needed.—A nozzle of glass or metal, for tying into the vein of the recipient, will be needed, and a piece of tubing to attach it to the syringe or syphon. These, or their ready-made substitutes, ought seldom to fail. The end of the nozzle, if cut obliquely, will enter the opening in the receiver's vein more easily. A bulbous end, advocated by some to make the tying in more secure, seems hardly necessary.

Mode of Procedure.—(*a.*) *In transfusion of water or saline solution.*—Expose a large vein in the recipient—Median Basilic, for preference. Should it be invisible owing to anæmia, cut down over its usual site, and look for it. Pass a double catgut ligature under

it. Tie the distal one to prevent bleeding. Nip up with forceps a piece of the coat of the vein, and incise it with knife or scissors. Enter the nozzle and secure it in the vein with the proximal ligature. Having filled a previously warmed syringe with the necessary fluid, connect the syringe to the nozzle by means of the rubber tubing, and introduce the fluid very slowly, excluding all air. *N.B.*—If there is no blood to flow back and so displace the air in the nozzle, it should be filled with saline fluid before it is tied in. After withdrawing the nozzle, either tighten both ligatures and cut the ends short, or remove them both and stop bleeding with a pad. Apply protective and absorbent wool or boracic lint. If the wound has been large, a stitch may be required.

(*b*.) *In Blood Transfusion.*—This may be either mediate or immediate. The latter involves special apparatus, and does not present any advantage commensurate with the trouble it entails. Clotting of blood in the apparatus or in the recipient's veins is most to be feared. The mediate method may be carried out either (1) by whipping the freshly-drawn blood with fine twigs, so as to remove the fibrin; or (2) by adding a 5 per cent. solution of phosphate of soda (1 oz. to the pint of distilled water), in the proportion of 3 of solution to 1 of blood, and injecting the mixture. The phosphate of soda prevents coagulation. This, known as Hicks' method, was introduced by J. M. Cotterill into Edinburgh, where it has been largely and successfully used.

While a nozzle is being tied into the vein of the recipient as above, the arm of the giver is prepared for venesection. A bandage is applied to the upper arm to restrict the venous return. The skin over the median basilic is cleansed and purified, and an oblique incision is made through it into the vein. The blood which flows is caught and rapidly stirred in a vessel containing the warm phosphate of soda solution, of which the quantity required has been fixed beforehand. To prevent the mixture from cooling, the vessel containing it should be kept floating in a basin of hot water. A glass syringe holding 8 to 10 ounces should be made ready by purifying it with corrosive or other antiseptic lotion, and then washing it out with hot boiled water. A piece of india-rubber tubing similarly cleansed, 5 or 6 inches long, should be used to connect it with the nozzle in the vein. While still hot, the syringe should be wrapped in a hot towel, and filled with the blood mixture. The blood of the receiver having been allowed to flow back so as to displace air in the glass nozzle, the latter should be attached by the india-rubber tubing to the syringe. Air in the syringe may either be displaced, or it may be kept from entering the veins by injecting with the handle-part of the syringe raised, and the injection stopped before the air is expelled. The syringe may be refilled as often as required (Fig. 28).

John Duncan, in cases of injury, has modified the process of transfusion by reinfusing the blood, which escapes from the patient's own limb when the bruised and torn tissues are divided. This, in bad cases, is caught, and mixed with the phosphate of soda solution,

and reinjected into the veins instead of being lost. Several very desperate cases have been successfully treated in this way, but the greatest care must be taken that the blood is fresh, and not already contaminated with septic organisms.

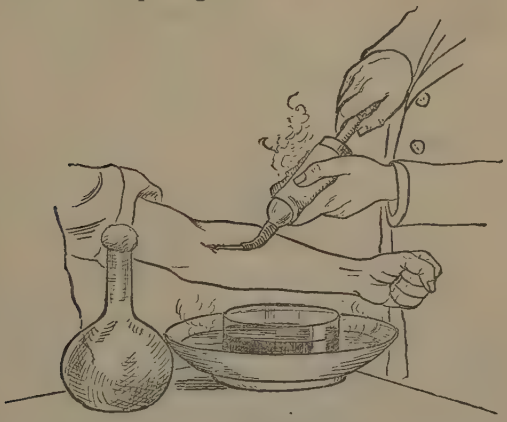


Fig. 28.—Transfusion of Blood.

William Hunter believes, as a result of experiment, that phosphate of soda solution hastens the destruction of coloured blood-corpuscles in the liver, and, therefore, that the corpuscles injected along with it are not likely to be of any service, especially as he holds that, in any case, all foreign corpuscles are more or less rapidly destroyed after transfusion of blood.

When whipped blood is used, the process is similar, except that whipping with fine twigs, and subsequent straining through muslin, is used instead of stirring with phosphate of soda solution. The former process removes the fibrin, the latter prevents it from forming.

CHAPTER VIII.

SHOCK AND WOUND-FEVER.

Contents.—Shock—Symptoms and Treatment—Syncope—Wound-Fever—Pulse and Temperature Indications—Treatment—Inflammation—Treatment by Antiseptic Poultices, by Blood-letting and by Counter-irritation.

Shock.—Whatever be the cause of the condition—*e.g.*, extensive crushing of a limb, or especially, of the abdominal viscera, severe

burn, loss of blood, great pain, or extensive operation—the symptoms and treatment are similar.

The **Symptoms** are pallor, and moisture of the skin—feeble, fluttering pulse—soft shallow breathing, and great languor.

The **Treatment** may be summed up briefly as follows :—

(1) *Relief* of immediately severe *pain* by hypodermic injection of morphia, and removal of any obvious cause of suffering.

(2) Zealous supply of *external warmth* by hot bottles, hot plates, and blankets—administration of hot tea or coffee, Liebig's extract, or gruel.

(3) As to *alcoholic stimulants*—Omit them if, with the above means, the patient tend to rally, as they are apt to cause an over-reaction. If, however, reaction be delayed or seem doubtful, ply the stimulants *ad libitum*, till improvement begins.

Where the patient cannot swallow, give enemata of brandy or whisky (1-2 oz.), or inject ether or alcohol (30 min.), subcutaneously, and repeat if required.

Syncope, or fainting, is treated by increasing the cerebral circulation, and stimulating the sensory nerves. In many cases, if the patient be sitting when faintness comes on, much benefit will be derived from bending the trunk and forcing the head well down between the knees. After fainting has occurred, the patient should be laid flat on the back, and all tight clothing on the chest or abdomen relaxed. The face may be slapped with wet towels, and the nostrils stimulated with ammonia-vapour. A stimulant of wine, spirits, ether, or sal-volatile, should be given, as soon as the patient is able to swallow.

Wound-Fever.—(*a.*) **Pulse-Indications.**—In regard to the pulse-tracings, it may be noted that, to surgeons, the frequency is of the highest importance, and a continuously rapid pulse may give warning of evil long before the temperature signals danger. Besides frequency, rhythm is also to be noted. A pulse over 120, with variable regularity, always gives rise to anxiety. It will be found that the pulse of inflammation generally is hard and full, while that of peritonitis is small and wiry. Previous to operation, there should be a careful examination made of the state of the circulation. The force of the heart's action, as modifying the choice of an operation or anæsthetic; the condition of the pulse, as indicating the presence of atheroma; aortic regurgitation and the tension associated with kidney-disease: are also well worthy of study. Slowing of the pulse is characteristic of cerebral compression.

(*b.*) **Temperature-Indications.**—Rise of temperature is a condition seen in fever and inflammations. Since the temperature is not so likely to be influenced by emotional and slight causes as the pulse, it furnishes more reliable data; but there are certain dangerous conditions, which are often *not* characterised by a rise of temperature. Thus we find that some rapid and violent septic poisonings, peritonitis, empyema, and even cerebral abscess may exist without it. Again, very high temperatures have been recorded as the result of injuries in special regions—as, for example, in fracture of the

cervical spine (110° F.), and in some cases of cranial tumour. These, however, are altogether peculiar, and may have relation to heat-centres, more especially since very low temperatures (85° F.) have also been observed in connection with some spinal and cranial lesions. On the second and third day after most injuries, even although subcutaneous or a-septic (as, for example, simple fracture), a rise of one or two degrees takes place, and the same phenomenon attends on antiseptic wounds. This, then, gives no cause for anxiety. It may be due to some waste product circulating in the blood; but we are in the dark as to its precise origin. A very different rise follows the advent of sepsis. This shows itself generally by a marked and increasing rise of temperature, which, however, gradually falls as granulation advances, and the wound no longer absorbs. Where abscess forms, rigors take place with marked rise. If constitutional blood-poisoning develops, the temperature may vary from the regular nocturnal increase of hectic to the more erratic jumps and relapses of pyæmia. When tension is associated with pain, as in whitlow and orchitis, increased heat is also present, and this abates at once on removal of tension.

A rise of temperature is of graver import in the aged than in adults, and in adults than children. Where 104° is reached the prognosis is always guarded, if the temperature does not speedily yield to treatment. The conditions of shock and loss of blood always give rise to low temperature. The advent of erysipelas is often indicated by a rise of temperature, although no other symptoms have appeared.

Treatment.—We may look upon the most serious accelerations of pulse and temperature in surgical cases as generally due to wound-fever, *i.e.*, a true septic absorption, and therefore preventible. The *treatment* where this fever occurs, then, is—not so much to lower the temperature by the administration of drugs but—to stimulate the patient, and enable him to combat the poison he has absorbed, and to prevent the entrance of more. Stimulants and strong cardiac tonics are therefore desirable, until the purification and free drainage of wounds amend the local condition. When wounds have become distinctly septic, and general blood-poisoning ensues, the best treatment is to remove all the stitches, and purify the wound-surface. In some cases, the part may even be removed entirely, as, for example, in pyæmia or septic gangrene, where amputation may save the patient's life. Irrigation, free drainage, and pure air are necessary. The rise of temperature due to local tension and pain may subside under the soothing application of an ordinary or antiseptic poultice to the part. If the condition persists, free incision is indicated, more especially if pus has formed. The urethra and bladder often exhibit most interesting phenomena in regard to rigors and fever in their reaction to instrumentation. A great rise and rigor often follows the passage of a catheter in some individuals. This is obviously nervous in origin. Again, there may be no trouble till the patient makes water. This is sometimes followed by a rise due to the absorption of some alkaloid from the urine.

Finally, the urine itself may become infected from a dirty instrument, and from this a true catheter-fever, septic in character, due to absorption, may follow.

Where other means have been ineffectual, general and local remedies are required. We may attack the fever by specifics such as quinine, antipyrin, and the like, or act on the skin and circulation, and so cause lowering of the temperature. The most energetic mode of cooling the patient is by means of Leiter's iced-water coil (Fig. 29).

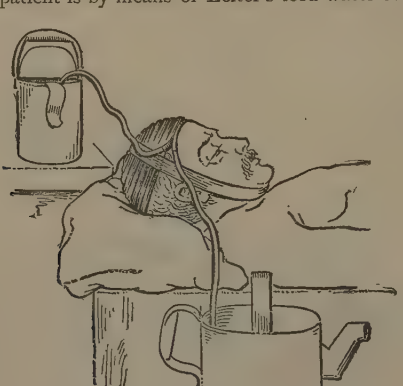


Fig. 29.—Leiter's Iced-water Coil.

This method is also applicable as a local antiphlogistic in inflammation of joints, &c. When there is rise of temperature *with a scanty secretion of urine* (as, for example, after abdominal operations), the hot "pack" is indicated. This is readily carried out by rolling the patient in a blanket, after placing around him hot bottles enveloped with moist warm flannel or stockings.

Inflammations, which threaten to form abscess, often yield to *antiseptic poultices*. These are made by enveloping the part in boric lint, soaked in carbolic lotion, and covered with mackintosh or guttapercha. Local blood-letting is often serviceable.

Blood-letting by leeches, or otherwise, is not often employed now, but may be useful in acute inflammations.

(1) **By Leeches.**—Leeches are to be applied as follows:—The part of the skin selected is washed and, if hairy, shaved; it is then dabbed over with milk. The leech or leeches are then taken from the box in which they are usually sent up, and allowed to swim for a few minutes in a basin of clean water. Each, before being applied, should next be allowed to crawl over a clean towel for a few minutes. It is then to be taken up in a wine-glass, or test-tube, which, when inverted, is placed

over the desired spot. Considerable patience is often expended before the leech can be induced to fasten; when it has once taken hold, it may be left till it becomes distended, and drops off.

Leeches to mucous surfaces (as of the vagina), must be applied in carefully adjusted test-tubes.

When much blood has to be removed, the leech-bite should be fomented with warm water.

When the bleeding continues too long, pressure with a pad will generally stop it; but if this fail, the leech-bite should be touched with a point of solid nitrate of silver.

The continuance of the flow is due to the anti-coagulating substance secreted from the leech's pharynx (*Haycraft*).

(2) **Cupping**, like leeching, has now gone too much out of use. In dry cupping, the blood is only drawn to the surface; in wet cupping, it is withdrawn from the body.

(*a.*) For *dry* cupping, if a cupping glass is not at hand, an empty jelly-can (jam-pot), cup, or strong tumbler, will do as well. A flat surface of skin should be chosen; this should be wetted. The interior of the cupping-glass should then be well heated (to expel the air), either by holding it over a spirit lamp, or by throwing a piece of lighted paper into it. In the latter case, the paper should be extinguished by clapping the glass against the skin; in the former case the glass should be withdrawn from the flame, and immediately pressed into its place on the skin. A vacuum is produced inside the glass, and the skin, deeply congested, rises up into it.

(*b.*) For *wet* cupping, a set of cupping knives are needed; these consist of 10 or 12 sharp blades, working in a half circle through slits in a metal plate fixed to a frame. The distance to which the blades project beyond the plate can be regulated by a screw. The blades are first brought through their course against a spring, and are held there by a catch, "full cock." When a button is pressed, they spring back at once, sweeping over the slits to the depth already regulated, and of course make corresponding cuts in whatever comes in their way. The depth of the wound must vary with the patient's skin. It should be just through the skin, but not into the subcutaneous fat, lest pellets of fat should block the cuts, and stop the needed bleeding.

Having adjusted the depth of the knives, and having placed the instrument at "full cock," the surgeon first dry-cups the desired place; then pressing the brass plate against the skin, he discharges the knife-blades, and immediately applies the exhausted cupping-glass again, which will now rapidly fill with blood. It must be emptied, and re-applied as often as required. The wound, after having been cleaned, should be dressed with dry boracic lint, or absorbent wool.

(3) **Venesection.**—Used generally to be practised from the median basilic vein. A fillet is placed on the upper arm, to retard venous return, and an oblique puncture is then to be made through the skin, into the vein, with a sharp-pointed bistoury, or lancet. Blood will now flow freely. If it becomes sluggish, the patient should work the hand and fingers vigorously. From 8 to 20 ounces may be withdrawn at a sitting.

In special cases, any distended vein may be selected.

A dry pad fixed over the wounded vein is all that is needed to stop the blood, after the fillet has been removed.

(4) **Arteriotomy** may be needed when blood has to be abstracted rapidly. The temporal artery is generally chosen from its convenient

position and size, and from the ease with which it can be stopped by pressure. The artery must be wounded, but not divided entirely. When the requisite amount of blood has been obtained, the vessel should be completely severed, and firm pressure with a pad applied.

Counter-irritation may be applied by blisters, by cautery, or by other means.

By Blisters.—A fly-blister of the desired size is applied to the skin, and left on for 6 to 8 hours; or blistering-fluid is painted on the part until it becomes white. The blister which rises is then snipped, and the raw part dressed with zinc ointment, oil-silk, or wet boracic lint.

By Cautery.—(*α.*) *The button cautery.*—This is heated in the gas or spirit-lamp, as indicated in Fig. 30, until the forefinger feels uncomfortable; and is then rapidly tapped over the skin at various places, so as to leave a reddened spot behind it each time. (*β.*) When the actual cautery is applied, a red-hot iron, or the *thermo-cautery*, is needed, and an anæsthetic is indicated. The skin should be first cleansed. The burn ought *not* to destroy the whole depth of the epithelium; if the seared part be at once covered with collodion, no further dressing will be needed.

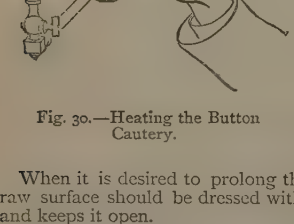


Fig. 30.—Heating the Button Cautery.

When it is desired to prolong the action of any counter-irritant, the raw surface should be dressed with sabine ointment, which irritates it, and keeps it open.

By **Potential Caustics** (see *Appendix*).

By **Croton Oil**, which, when rubbed into the skin, is a powerful counter-irritant, and causes a smart pustular eruption.

Tincture of iodine is a mild counter-irritant. The liniment of iodine is much stronger.

CHAPTER IX.

EMERGENCY CASES.

Contents.—A. Treatment of Surgical Emergency Cases—(1) Retention of Urine (from Stricture of Urethra; Enlarged Prostate; Spasm of Constrictor; Acute Inflammation of the Prostate; Urethral Calculus)—(2) Possible Rupture of the Urethra—(3) Possible Rupture of the Bladder—(4) Possible Injury of the Intestines—(5) Strangulated Hernia—(6) Severe Compound Fractures and Dislocations—(7) Injuries to the Eye—(8) Lodgment of Needles under the Skin—(9) Foreign Body in the Nostril—(10) in the Ear—(11) Obstruction to Respiration (from Swelling of the Fauces; Croup, or Diphtheria; Foreign Body in the Air-passages, Pharynx, or Œsophagus)—*Artificial Respiration*—(12) Treatment of the Apparently Drowned—(13) Severe Head Injuries—(14) Cut-throat.

UNDER the category of "emergency" cases—cases in which prompt

and decided action is necessary—come both Surgical Cases (strictly so called), and Cases of Poisoning.

A. Surgical Emergency Cases.

In the prognosis of surgical cases, as of others, we have to consider remote as well as immediate dangers. The latter draw attention to themselves, but the former, only appreciated by experience, are apt to be unheeded until the time for their remedy has gone. Under the head of "emergency" cases we wish, therefore, to allude briefly to the diagnosis and treatment of cases involving both classes of danger.

(1) **Retention of Urine**, almost invariably found in males. If recent, causes great pain and feeling of distention, and demands relief by the patient's symptoms no less than by the dangers which threaten him.

If left to itself, the pressure may cause a rupture of the urethra, and extravasation of urine into the perinæum, or, aided by only a slight blow on the abdomen, a still more serious pelvic, or abdominal extravasation from a rupture of the bladder. Failing these, suppression of urine, and uræmic poisoning may occur, from backward pressure upon the kidneys, or there may be a long standing after-paralysis of the bladder.

The *cause of the retention* may be anything that obstructs the canal of the urethra—whether stricture, enlargement of the prostate, inflammation or abscess of the body of the penis, urethral calculus, or spasm of the constrictor. (Retention due to paralysis of the bladder is a serious symptom of a more extensive paralysis.)

The diagnosis of the retention is made by percussion and palpation just above the pubes, taken together with the previous history. The distended bladder can often be made out as a fluctuating tumour, reaching even as far as the umbilicus. The diagnosis of the cause of the retention will vary with the conditions.

(*a.*) *Retention from Stricture of the Urethra.*—Here we have generally the history of a gradually diminishing stream with painful and frequent micturition, following sooner or later after gonorrhœa or an injury to the perinæum; exposure to cold, or a bout of drinking, may determine the complete obstruction. By passing the finger gently along the urethra from the outside, the amount of callous thickening in and around the tube can be recognised.

When an urgent case of stricture is brought to hospital, the patient should be put to bed, if possible, before any effort is made to treat him.

Treatment.—Having gently ascertained the amount of bladder distention, the house-surgeon selects a medium-sized (say number 8, English) catheter, and after it has been well oiled—(using carbolic 1-40, or eucalyptus 1-12) passes it along the urethra to explore its condition and find the seat of stricture. In most cases, this will be just in front of the triangular ligament, but there may be several

strictures. Next, a soft instrument, either india-rubber or one of the French black probe-pointed kinds, is to be taken and an effort made to pass it. Successively smaller numbers must be tried, and should the smallest fail, metal catheters must be used. In proportion as greater command is obtained with these by their rigidity, so is there greater risk of their doing harm, especially when of small size. Until the feeling of being grasped is perceptible, the greatest gentleness must be employed, lest the urethra, anterior to the stricture, should be perforated and a false passage made. When the stricture has been entered, there will be generally increased pain. Any attempt at withdrawal will be resisted by the grasp of the stricture, and the operator may have more confidence in gently pushing the instrument on. After great difficulty has been met with in passing an instrument, it is often well to tie it in for six or eight hours, so as to produce vital dilatation.

When the smallest instruments are tried without avail, and if the symptoms are not very urgent, a morphia suppository should be given, and the patient put into a warm hip- or general bath. A urethral injection of a 4 per cent. solution of cocaine would also seem advisable. He may then be able to pass urine himself, or the next attempt with the catheter may be successful. If, however, the symptoms are urgent, there should be no hesitation in aspirating just above the pubes.

This is an extremely simple proceeding, may be repeated without hesitation over and over again (during five weeks it has been done regularly), and by removing the distention, it at the same time often relieves the spasm which complicates the stricture. The patient can often make water afterwards without assistance, or at least the surgeon's trouble is much relieved.

What is true for retention from stricture is true for retention from other causes:—*in all cases of urgency and difficulty, aspirate above the pubes.* Should there be no exhausting-bottle at hand, a vacuum is easily produced by first heating and then cooling a bottle with a tightly-fitting cork, perforated to transmit a connecting-tube. At the same time, negative pressure is not really required; an aspirating-needle, or fine trochar, is sufficient, and involves no danger so long as the surgeon sees that the intra-bladder pressure is naturally present, or is maintained by the hand over the abdomen until the needle is withdrawn. Where the bladder-wall is thick and hard from old standing inflammation, it tends to keep in a semi-contracted state; if compressed beyond this, it expands again at once like an india-rubber ball; and would draw air and organisms into the bladder, if the compressing hand were relaxed while the tube was patent.

(*b.*) *Retention from enlarged Prostate* is most frequent in old men, but otherwise from previous history might be mistaken for stricture. Except where the middle lobe is enlarged alone, and towards the bladder, a finger in the rectum feeling the prostate will generally make the diagnosis plain. Should the nature of the retention be doubtful, the passage of a large instrument will remove the uncertainty. No obstruction will be felt until the prostate is reached, and

there the difficulty, and a serious one, will be met with. To obviate the alteration in curve of the urethra due to the enlargement, which may be lateral as well as from below, we may use (1) a soft catheter with a "coudé" end; (2) a metal instrument with an extra large bend; or (3) a well-curved gum-elastic catheter with stilette, passed down to the obstruction. If the catheter be gently pressed onwards while the stilette is being withdrawn, the point of the former will be raised up and may be so guided past the obstacle into the bladder.

Should the prostate bleed, as it often does freely, the eye of the catheter may be blocked ere it reach the bladder. If this be the case a catheter with a plug at its extremity should be used; or a plug may be extemporised by winding a few turns of silk round the end of the stilette. To avoid any risk of leaving the plug behind, one end of the silk that made it should be left attached, and allowed to pass up the catheter beside the stilette.

Caution!—In no cases should greater care be taken to prevent septic mischief from entering the bladder than in those of prostatic enlargement, especially when relieved for the first time after an attack of retention. The whole of the urinary tract, from the kidneys to the prostate, is ready to inflame, even from the retention and the means necessary to relieve it; and should septic fermentation once begin, the combination of increased inflammation and septic poisoning will rapidly carry off the patient.

(*c.*) *Retention from Spasm of the Constrictor*, when occurring apart from any stricture, generally results from some irritation to the perinæal nerves. After an operation about the anus, or for piles or fistula, it is frequent, and is sometimes caused in children by worms. The spasms may occur in the course of feverish attacks, sometimes traceable to the highly acid, and hence irritating, quality of the urine.

Treatment.—Soothing remedies such as an opiate, or perinæal fomentations, are often sufficient; failing these, the passage of a soft instrument, with gentle, steady pressure when the obstruction is reached, will be required.

(*d.*) *Retention from Acute Inflammation of the Prostate.*—In these cases, the pain and feverishness of the prostatitis is an earlier and more prominent symptom than the retention. Soft catheters should be used, and if even these cause great irritation, it would be well to relieve by aspiration for several days. The rest thus gained to the prostate might turn the scale between suppuration and resolution.

Retention from other conditions of the penis, such as urethral abscess, is to be treated on similar lines, *i.e.*, by soothing, gentle use of soft instruments, and, if need be, aspiration.

(*e.*) *Urethral Calculus*, if it cannot be made to pass outwards, or seized with forceps and withdrawn, will require to be cut down upon. The visiting surgeon should, therefore, be sent for; but immediate relief can be given by aspiration.

(2) **Possible Rupture of the Urethra.**—If a case of fracture or crush of the pelvis, or severe injury to the perinæum, be admitted, the house-surgeon's duty is at once to pass a catheter and draw off the urine. Should the instrument pass easily and there be no blood, the urethra may be considered safe. Should, however, blood be oozing from the meatus and the passage of a catheter be impossible, the urethra may be considered to be torn across. Should there be some blood and a rugged feeling as the catheter is being passed, the tear will be partial. In the latter case, the patient should not be allowed to try to pass water himself; it should be drawn off at intervals of six to eight hours, for three or four days, or a catheter tied in continuously. When there is a complete rupture —any severe retention being meanwhile relieved by aspiration—the visiting surgeon should be sent for, and preparations made for perinæal section.

(3) **Possible Rupture of the Bladder.**—Such a condition may be expected when a person with a more or less filled bladder receives a violent blow in the hypogastric region, or when the pelvis is severely crushed. The diagnosis is chiefly made from the hæmaturia, not traceable to the kidney or ureter, from the small quantity of urine obtainable, and from the collapse. The patient must be put to bed, and treated with warmth and opiates, while the visiting surgeon is sent for. Preparation meanwhile should be made for laparotomy.

(4) **Possible Injury of the Intestines.**—Where there is a penetrating wound of the abdominal wall, whether from a stab or a bullet, it may be assumed that if the abdominal cavity has been reached, the intestines or other viscera will have been injured. Only in rare cases do they escape. Again, should the abdomen have been severely crushed or heavily struck, any of the viscera may be injured without the slightest trace of violence being visible on the outside.

It is now generally acknowledged that (at least, if the case can be seen before severe peritonitis has occurred), laparotomy should be performed for penetrating wounds of the intestine, so that apertures may be sutured and bleeding points tied. If the probable injury could be as nearly surmised in non-penetrating abdominal injuries, the treatment would be similar.

We may, therefore, lay it down as a rule that, in all cases where from the nature or history of the injury, especially if accompanied by great shock and by vomiting and hiccough, severe injury of the intestines is suspected, the patient should be sent to bed and kept absolutely quiet, while opium or morphia is administered. Nothing should be given by the mouth except a little ice to suck. Should extreme collapse indicate stimulants, ether may be injected hypodermically, or an enema of beef-tea and brandy administered by the rectum.

Meanwhile, the visiting surgeon should be sent for without delay; a few hours may make all the difference between the success or failure of a possible operation. If we wait until intestinal contents

have escaped into the peritoneum, and septic peritonitis has been well established, the patient's chances of recovery are greatly diminished.

(5) **Strangulated Hernia** is always a matter of great anxiety. The only question that a house-surgeon may have to settle is: how far should he go in efforts at taxis before sending for the visiting surgeon, and what treatment should he adopt pending his arrival?

It is impossible to lay down definite rules for all cases, but the following general indications may be useful:—

No effort at Taxis should be made (*a*) if there be signs of local change, such as inflammation, emphysema, or bruising, at the hernial protrusion.

(*b*.) If extensive efforts have been already made without success before admission.

(*c*.) If symptoms have been very acute, *i.e.*, great pain, vomiting, and collapse—even although lasting for a few hours only.

(*d*.) If the distinct symptoms, even though not very urgent, have continued for two or more days.

The indications of strangulation are—*locally* hardness and irreductility, pain and tenderness, loss of impulse on coughing; *remotely*, pain in the abdomen, often felt at the umbilical region, nausea, sickness, and vomiting, becoming stercoraceous, collapse with rapid weak pulse. There is generally complete constipation; but the passage of fæces which had lain low in the great intestine is sometimes deceptive.

Mr. Spence's dictum used to be: "When in doubt, operate;" and the house-surgeon may assume this as the indication for sending for his "Chief." Meanwhile, the pubes should be shaved, the parts covered with a towel soaked in carbolic (1-20), or corrosive sublimate (1-1000), and an ice bag laid over the hernia—at least, for an hour or so. The foot of the bed may also be well raised. Any great pain should be soothed by morphia. By these means the tension in the sac will be lessened, and the way prepared either for taxis or an operation, as the visiting surgeon may think fit. On the other hand, should the symptoms be slight and of short duration, the house-surgeon may very gently try taxis, but the efforts should be gentle and short. Should the parts seem inclined to yield, a slight interval may be allowed to give a chance to the cold, and to the raised position of the pelvis, when a second trial, aided with chloroform, may be made. Should this fail, a "doubt" will exist, and the case must be treated accordingly.

It is not the purpose of this work to discuss the form of operation for strangulated hernia.

Taxis is performed by first relaxing the hernial openings by raising the shoulders, and flexing and adducting the thighs (femoral, and inguinal hernia). The surgeon grasping the protrusion with one hand, draws it away, and at the same time gently compresses it, while with the other, applied at the neck, he pushes up bit by bit *in the direction of the canal-opening*. This it will be remembered runs in the same direction as the hernia in the

inguinal form, while in femoral hernia, the protrusion passes up and out, and hence will have a corresponding relation to the canal.

(6) **Severe Compound Fracture or Dislocation.**—While, as elsewhere laid down, the first object aimed at should be to render all compound wounds a-septic, the injury may yet be so severe as to necessitate an immediate amputation or excision.

When the parts are severely bruised and crushed, the impossibility of saving them will be evident. In others, however, the matter may be difficult to settle. Causes for anxiety are, the absence of pulsation in the main vessels below the seat of injury, or of capillary circulation, illustrated by pressing and relaxing any vascular part; extensive stripping off, or undermining of the skin, great comminution of the bones, and a pulpy bruised state of the muscles, even though the skin seem fairly natural. The elasticity and pliability of the skin will permit of an almost complete pounding and crushing of the deeper textures, without external marks being visible, at least at first. However, the vitality of the skin may be so injured by stretching and bruising, that it will afterwards die, although at first it looks only a little pale or livid.

(7) **Injuries of the Eye.**—(*a.*) *Foreign bodies on the surface* must be removed from the conjunctiva at once. If loose, and not immediately apparent, they will be found beneath the upper lid, which should be everted as follows:—

Direct the patient to look down to the ground; lay hold of the margin of the upper lid (or of the eyelashes), and draw it down, and away from the globe; then, placing a blunt pencil, or the flat handle of a pocket-knife upon the upper part of the upper lid to steady it, rapidly fold the lid upwards, and it will become everted. If, while it is held thus everted, the patient looks down, the upper angle of the conjunctiva can be easily explored, and any foreign particle picked off or wiped away.

Should a small particle of stone or metal have lodged in the surface of the cornea, constituting a "fire," it must be very carefully removed with a spud, the cornea having previously been rendered insensible with a few drops of cocaine (4 per cent.) The greatest care must be taken to avoid unnecessary injury to the corneal epithelium in this process.

(*b.*) *Where the eye has been cut*, any escape of the vitreous humour is serious. One of the immediate risks in cuts of the eye-ball is a prolapse of the iris; therefore, if the cut should be at the centre, the pupil must be dilated with atropia; whilst, if it be at the margin, it must be contracted with eserine. A dry pad and bandage must then be applied on the closed eyelid. It is not usually necessary to do anything further at the time, unless the corneal cut should gape very widely, when it may be drawn together with a fine stitch.

(8) **Lodging of Needles beneath the Skin.**—This is a common accident, and often causes greater anxiety to the patient than the slight risk involved can account for. No attempt should be made to remove a foreign body, unless it can be seen or felt through the unbroken skin. In a suitable case, begin by rendering the part

bloodless, then anæsthetic, either by freezing with ether, or by injecting cocaine.

Next, incise the skin over the foreign body, and use the end of the dissecting forceps as a probe, first to detect, and then to remove it. Sometimes the intruder, though previously felt, eludes the first effort made to find it; but it is easily recognised, and seized the following day, if the wound has been meanwhile plugged with boracic lint. Joseph Bell used often to demonstrate the value of this plan at his out-patient clinique in the Royal Infirmary, Edinburgh.

(9) **Foreign Body in the Nostril.**—Children often push seeds, or small stones "up their nose," and cannot get them out again, because the aperture of the nostril is narrower than its cavity. When this accident has occurred, one of the best and simplest instruments for extraction is a loop of soda-water bottle wire, bent on the flat. This may be gently slipped over the foreign body, and next made to pass behind it by raising the handle part of the loop. A pull outwards is then all that is required. Failing this method, dressing or dissecting forceps may be used to grasp and pull out the body, or to push it back into the pharynx. Great gentleness, it is perhaps needless to say, is always necessary.

(10) **Foreign Bodies in the Ear**, like those in the nose, are difficult to extract, and for a similar reason—the aperture of the external meatus is narrower than the canal beyond.

The membrana tympani closing the canal within is, moreover, a special feature in the case of the ear, necessitating greater care, lest efforts at removal should only drive foreign bodies further inwards, and so injure it. At the same time the closure of the canal within by the membrane ensures that a stream of water injected into the canal will be turned, and made to flow out again the same way, carrying any foreign body that may be present with it, or, at least, bringing it within range of a loop of wire (see section 9), or a pair of fine forceps. Besides the wire loop, syringing (see Chap. xxv.) is therefore of great service in dealing with foreign bodies lodged in the external meatus.

In more difficult cases, an ear speculum, good light, and special forceps, may be required, and if there be an aural department of the Hospital, the patient should be sent there for treatment.

Insects in the meatus are best removed by the insertion of a few drops of olive oil, poured in while the patient lies down. The insect is drowned, and floated up within reach.

(11) **Threatened Obstruction to Respiration.**—Under this head may be included many urgent cases, differing very widely from one another, in their nature.

The first point to be determined is:—How far does any existing dyspnœa depend upon obstruction in the air-passages, rather than upon some fault in the blood or its circulation? This is judged of by observing the movements of the thorax, and noting the amount (if any) of the sucking in of the unsupported portions of the thorax, such as the intercostal spaces, inter- and supra-clavicular notches and upper part of the abdomen, and by determining its relative

amount on the two sides. Next, we must localise the seat of obstruction, if present; for should it be below the upper part of the trachea—unless a removable foreign body—surgical interference will be useless. By auscultation and percussion we can make out signs of obstruction or disease in the air-passages within the lung. Inspection through the mouth and examination of the neck will show the condition of the pharynx, and sometimes indicate that of the larynx. Where the larynx itself is involved, the laryngoscope may be needed. Laryngeal obstruction is generally worst in inspiration, and causes crowing sounds. When both the larynx and the parts below are at fault, we must determine which is most to blame, comparing the manifest dyspnœa with the laryngeal and thoracic sounds. An indication may thus be gained, but precision is difficult to attain.

Supposing the obstruction to be at the glottis, the treatment will vary with the cause and with the views of the operating surgeon. Some of the more frequent causes of obstruction are :—

(*a.*) *Swelling of the Fauces and Glottis.*—As the result of a burn—a child having tried to drink scalding tea—for instance. It is difficult to say to what extent the swelling will go in any one case. Efforts should be made to limit it by giving the patient ice to suck, and applying cold continuously to the outside of the throat, and by scarifying the swollen fauces. Tracheotomy should be postponed as long as possible; but provision for it should always be at hand, as it may be required at a moment's notice. In any case, while dangerous symptoms last, every draught of cold air should be excluded from the patient, and steam from a bronchitis-kettle constantly plied round him.

(*b.*) *Croup and Diphtheria.*—These may be classed together, for although well-marked examples of each are distinct from one another, many cases are very doubtful. The points of distinction are considered to be the following—viz., that *croup* is a local inflammation of and exudation of false membrane in the larynx, extending downwards into the bronchi, producing also spasm of the glottis. It is said to kill by dyspnœa alone. When the local obstruction is removed, improvement is rapid. *Diphtheria*, on the other hand, is (in the later stages at least), as much a general as a local disease. There is also an exudation, but this is partly a slough, and when removed leaves a raw surface. The fauces are affected first. The same tendency to spread down into the lungs exists; but there is, besides, a general poisoning and depression for which local symptoms do not account. Recovery is slow and often complicated with paralysis and by albuminuria.

Should **diphtheria** be diagnosed, the question will be—is the patient suffering from tracheal obstruction, or from general poisoning? If from the former, an operation may be considered; if from the latter, it would be of little permanent use. When the local symptoms seem to be getting steadily worse and to be the chief evil, the free entrance of air should be ensured. Symptoms are then relieved.

If it be a case of **croup**, the chief consideration will be :—is the

obstruction above or below the glottis and trachea? in other words, would an opening into the larynx or the passage of a tube from the mouth do any good? If so, and if steaming, nauseants, and poultices and sometimes bloodletting have done no good, an operation will be indicated.

The rules for an emergency case of tracheal obstruction from any other cause may be likened to those for simple croup.

(*c.*) *Foreign Body in the Air-passages.*—Whether this be a seed, small coin, or other object, it places the patient in imminent risk of choking at any moment. It may be lodged in one of the ventricles of the larynx, or have passed down the trachea into the bronchi. If a patient be brought into hospital with a history that points to such an accident, and should no symptoms be immediately pressing, he should be put to bed as quietly and speedily as possible, no exertion being permitted, lest the foreign body be disturbed and come into a more dangerous position, or cause spasm of the larynx. All preparations for tracheotomy (see Chapter xi.) should then be made, and the visiting surgeon sent for. A bad fit of choking may necessitate tracheotomy at any moment.

No efforts should be made at inverting the patient and shaking the foreign body out, so long as it lies in a harmless place, or, unless the operator is prepared to perform tracheotomy at once. The glottis might become suddenly closed, either by reflex spasm or by direct lodging of the foreign body between the cords.

(*d.*) *Foreign Body in the Pharynx.*—An obstruction, such as a piece of meat, is generally remedied by withdrawing it, or pushing it down with the finger. Sometimes a hard body lodged in the œsophagus (below the larynx) may interfere with respiration, by pressing forwards into the unprotected part of the trachea. These rarer cases will require special treatment.

(*e.*) *Foreign Body in the Œsophagus.*—Many foreign bodies, even of large size, when swallowed pass down to the stomach, and are discharged per anum. They may stick in the œsophagus, however,

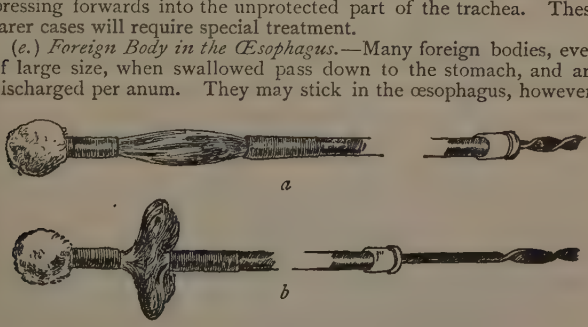


Fig. 31.—The Umbrella-Probang.—*a*, closed; *b*, open.

and either cause difficulty in swallowing, or involve risk by ulcerating through the œsophagus into the aorta or air-passages. Sometimes they lodge in pouches of the mucous membrane, and pass for long undetected. If inspection of the fauces and examination with the

finger reveal nothing, a probang may be passed down the œsophagus. If a foreign body be felt in the upper half of the passage, long forceps may be tried, to grasp and remove it. Should this endeavour fail, œsophagotomy will be indicated.

For Fish-bones and other irregular bodies, the umbrella-probang is useful (Fig. 31). This, while closed, is passed beyond the intruder, and then, when opened, is withdrawn. Frequently it brings with it the foreign body entangled in its meshes.

For Coins, the coin-catcher (Fig. 32) is useful—a gag must be

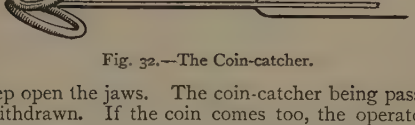


Fig. 32.—The Coin-catcher.

used to keep open the jaws. The coin-catcher being passed, is then carefully withdrawn. If the coin comes too, the operator must be ready to guide it past the epiglottis with his left forefinger. It is apt to slip off the coin-catcher at this point, and either stick at the epiglottis or be swallowed again.

Artificial Respiration may be necessary after the obstruction to the breathing has been removed in any of the above cases.

In asphyxia, generally, for several minutes after breathing has ceased, the heart continues to beat. So long as it does so, the prospects of restoration by artificial respiration are good. When the heart's action, however, as well as the movements of respiration, has stopped, the chances are very small. Although Milne Murray has shown by experiment that *in animals* animation may be restored by artificial respiration after both pulse and breathing have ceased, clinical experience proves that *in man* the prospects of recovery under similar circumstances are by no means so good.

Many methods of artificial respiration have been proposed, the object in all, however, is to alternately increase and diminish the capacity of the chest, so as to make air pass in and out. The simplest and readiest way, is to press with the hand upon the sternum and then suddenly relax it. **Sylvester's method** which is the common, and a more efficient plan, is carried out as follows: the patient's head is kept low, the chin being drawn well up, or the tongue pulled out with forceps; the chest is raised; one person then grasps the patient's arms just above the elbow, and draws them with a sweep to above the head (Fig. 33); in about two seconds, he brings them down again to the front side of the chest, against which he presses them very firmly (Fig. 34), while an assistant at the same time drives the abdominal viscera upwards, towards the diaphragm to complete expiration. After a pause of four or five seconds, the movement is begun again. About fifteen respirations per minute are all that is required.

Marshall Hall's Plan of rolling the patient alternately from his

back to his side is clumsy and laborious, and is now superseded by *Sylvester's* and *Howard's Methods;* the latter the inventor describes (with special reference to drowning) as follows:—

"Instantly turn patient downwards, with a large firm roll of clothing under stomach and chest. Place one of his arms under his forehead, so as to keep his mouth off the ground. Press with all your weight two or three times, for four or five seconds each time,

Fig. 33.

Fig. 34.

Artificial Respiration—Sylvester's Method (table also tilted).

upon patient's back, so that the water is pressed out of lungs and stomach, and drains freely out of mouth. Then, *quickly* turn patient, face upwards, with roll of clothing under back, just below shoulder-blades, and make the head hang back as low as possible. Place patient's hands above his head. Kneel with patient's hips between your knees, and fix your elbows firmly against your hips. Now—grasping lower part of patient's naked chest—squeeze his two sides together, pressing *gradually* forward with all your weight, for about three seconds, until your mouth is nearly over mouth of patient; then, with a push, *suddenly* jerk yourself back. Rest about three seconds; then, begin again, repeating these bellows-

blowing movements with perfect regularity so that foul air may be pressed out, and pure air be drawn into lungs, about eight or ten times a minute, for at least one hour, or until patient breathes naturally."

Besides artificial respiration, efforts should be made to rouse the system by various forms of stimulation, such as by vapour of ammonia to the nostrils (burning feathers before the nose, hartshorn, &c.); ether or alcohol vapour by the lungs, by subcutaneous or rectal injection; flipping, pinching, and blistering the skin; interrupted current to the skin, muscles, or over the heart; friction and hot bottles to the extremities.

(12) **Treatment for those apparently drowned.**—No time should be lost in trying to restore respiration. Weeds and mud must be cleared from the mouth, and water squeezed out from the lungs and stomach, as Howard describes (p. 75). Artificial respiration by either Sylvester's (p. 74) or Howard's method (p. 75) should then be begun. Meanwhile, the limbs should be smartly rubbed towards the trunk with the hands or warm flannels. If circumstances permit, the patient's wet clothes may be removed and warm blankets be substituted, while hot bottles, bricks, or plates are laid against them. On no account, however, should artificial respiration be intermitted, except for a few seconds at longest, until half or three quarters of an hour after the heart has ceased to beat.

Should spontaneous efforts at respiration return, exertions should be renewed, and at the earliest date that swallowing seems possible, brandy and water should be placed at the back of the tongue with a spoon. While circulation continues, a hypodermic of ether (20–30 min.), if available, may be given. After consciousness has returned, a warm drink of weak tea or coffee, beef-tea, or weak alcohol, should be given, and the patient put to bed with plenty of warm blankets. For some days after immersion, the patient must be treated with great care, lest pneumonia should develop.

(13) **Severe Head-Injuries.**—When a patient is admitted with a severe head-injury, the question of trephining will often arise, and the house-surgeon may be in doubt whether or not to send for the visiting surgeon. As authorities differ on these matters, we can only here indicate views generally accepted:—

Do not expect Trephining—

(*a.*) If the fracture seem to be chiefly on the base (*i.e.*, if blood and cerebro-spinal fluid run from the ears, or blood from the roof of the nose, or pharynx, and if there is no special paralysis or twitching pointing to localised hæmorrhage.

Treatment.—Get the bowels well opened, shave the scalp, and put on an ice-bag, and keep the patient quiet.

(*b.*) If the fracture be a simple one of the vault with not very extensive depression, and unaccompanied by definite symptoms.

Treatment, as above.

(*c.*) In a slight case of compound depressed fracture, where there seems good hope of keeping the wound a-septic. *Treatment*—Dress wound, otherwise as above.

Expect Trephining—

(*a.*) In a compound fracture with distinct depression, with or without symptoms. *N.B.*—This includes punctured fractures.

(*b.*) In any severe head-injury, with well-marked hemiplegia, aphasia, or other localised lesion, which may be cortical, whether these symptoms are early or late.

(14) **Cut Throat.**—The course to be pursued includes—

(*a.*) Arrest of hæmorrhage.

(*b.*) Treatment of injured trachea or œsophagus.

By the time cases of cut throat are brought under the surgeon's notice, often either the patient is dead, or bleeding has spontaneously ceased. The first duty of the surgeon will be, however, to look for and stop any bleeding that may exist. Cautiously he must remove blood-clots, and sponge the wound with an antiseptic lotion, secure bleeding points with forceps, and carefully ligature them. Next, he must examine the extent of the wound, and close with catgut stitches any apertures in the air- or food-passages, should they have been made. In such cases, he may also approximate the rest of the wound, but without entirely closing it, lest any discharge be pent up and burrow either into the wounded trachea or gullet, or under the fascia of the neck.

In cases where the cut has not wounded the trachea or gullet, the chances of septicity are much less, and an attempt should be made to render the wound a-septic, after which it may be closed with sutures. Watch should be kept, however, and on any sign of discharge-accumulation, the wound must be opened up again.

The after-management of the wound must be conducted so as to prevent discharge from entering the trachea or œsophagus, or from burrowing under the cervical fascia. The neck should be kept at rest, with the head bent forwards.

In cases where the thyro-hyoid membrane has been wounded, there may be great swelling and inflammation about the epiglottis and extending into the larynx. In bad cases, tracheotomy may be required, and, in anticipation of danger, it may sometimes be best to operate at once. Owing to the presence of dysphagia, it may be necessary to feed the patient with a catheter passed into the œsophagus, or nourish him by nutrient enemata till swelling subside.

In all cases, the constant presence of a skilled attendant is of the greatest importance.

Anæmia from loss of blood (p. 57), shock (p. 59), or excitement, must be treated by appropriate remedies.

CHAPTER X.

EMERGENCY CASES (*Continued*).

Contents.—B. Cases of Poisoning—Poisons most frequently selected—Classification of Poisons—"Emergency" Apparatus: the Stomach-Pump and its Syphon Substitute—General Treatment—Treatment for Special Poisons—Treatment for Poisons most commonly taken.

B. Cases of Poisoning.

CASES of poisoning are always anxious; acute ones are urgent. As treatment depends on diagnosis, no time is to be lost in forming it. Often the statement by the patient or his friends is sufficient. When this is not to be had, the diagnosis must be made on other grounds.

Poisons most frequently selected in Suicidal Cases.—Apart from the symptoms observable, it is of interest and importance to know what poisons are most frequently selected by suicides, or taken by misadventure. Morselli (On suicide—*International Scientific Series*, 1881), says—"In the aggregate of suicides which happened in England and Wales in 1863-74, the following poisons seem to have been always more used than any others; prussic acid, cyanide of potassium, laudanum, oxalic acid, arsenic, strychnine, the vermin-killer, and oil of bitter almonds; whilst in the second and third places are always found caustic acids, mercury, preparations of opium and morphia, vegetable narcotics, phosphorus, and salts of copper; lastly, though rarely chosen, come chloral, chloroform, paraffin, belladonna, ammonia, cantharides, salts of lead, zinc, and potassium.

It is remarkable that caustic alkalies are not found on the list. To compare with this statement of the use of poisons in England, the following Table has been drawn up from the Registrar-General's Report for Scotland for the last five years, showing the number of deaths by poisoning, both suicidal and accidental. It will be seen that opium (generally as laudanum) heads the list, and that prussic acid is much less used than it is in England.

1881–1885.

	Accident.	Suicide.	Total.
Opium (and Morphia),	80	42	122
Carbolic Acid,	8	5	13
Lead,	11	0	11
Chloroform,	10	1	11
Sulphuric Acid,	8	3	11
Chloral,	6	3	9
Belladonna and Atropia,	8	0	8
Phosphorus,	6	2	8
Strychnia,	4	4	8
Alcohol,	4	0	4
Cyanide of Potassium,	1	3	4
Hydrocyanic Acid,	0	4	4
Arsenic,	0	3	3
Spirit of Salt,	3	0	3
Salt of Sorrel,	2	1	3
Herbs,	2	0	2
Hydrochloric Acid,	0	2	2
Nitrate of Potash,	0	2	2
Nitric Acid,	2	0	2
Oxalic Acid,	0	2	2

As these, however, are all deaths, the next table is given to show the various cases treated for poisoning in the Edinburgh Royal Infirmary from 1877 to 1887 inclusive—eleven years. Most of the cases recovered.

Opium,	60 cases.		
Acute Alcoholic Poisoning,	30	,,	
Suspected Poisoning,	12	,,	
Coal Gas,	6	,,	
Strychnia, Morphia, Phosphorus, Chloral,	4	,,	each.
Ammonia, Oxalic Acid, Paraffin, Belladonna,	3	,,	,,
Chlorodyne, Iodine, Lead, Insolation,	2	,,	,,
Irritant, Atropia, Spirit of Salt, Sulphuric Acid, Aconite, Corrosive Sublimate, Bow's Liniment, Prussian Blue, Carbolic Acid, Chloroform, A. B. C. Liniment, Croton and Opium, Cyanide of Potassium, Creosote and Opium, Salt of Sorrel, Prussic Acid, Arsenic,	1	,,	,,

Classification of Poisons.—(1) *Irritants*, such as arsenic and cantharides, irritate and inflame; symptoms are delayed. *Corrosives* have immediate action; they soften and destroy the mucous membranes—*e.g.*, caustic alkalies, strong acids, corrosive sublimate, also, to a less degree, oxalic acid.

(2) *Narcotics* or cerebral poisons, producing stupor, delirium, convulsions, or coma—as opium, hydrocyanic acid, poisonous gases.

(3) *Narcotic-irritants* combine the effect of the above in greater or less degrees—*e.g.*, strychnia, aconite, hemlock.

Symptoms and Diagnosis.—When diagnosis has to be made from symptoms, the following tabular form, modified from that given by Murrell in his excellent work on "What to do in Cases of Poisoning," will be found useful:—

Collapse.—Prominent in irritant and corrosive poisons, and in all others towards the end.

Coma.—In opium and morphia, alcohol, chloroform, chloral, coal gas, prussic acid.

Excitement.—In alcohol (early stage), belladonna, hyoscyamus, cannabis indica.

State of Pupils.—*Contracted* in opium and morphia, and alcohol (sometimes). *Dilated* in belladonna and atropine, hyoscyamus, tobacco, and alcohol generally.

State of Skin.—Dry in belladonna and atropine. Moist in opium, aconite, and in collapse.

Time Symptoms take to appear.—Developed at once in corrosive poisons and in hydrocyanic acid. In others the time varies with strength and dose of poison, condition of stomach as to food, and idiosyncrasy of patient. Effects of arsenic and phosphorus are often delayed.

Smell of Breath.—Characteristic in laudanum, alcohol, carbolic acid, &c.; in phosphorus poisoning there is a smell as of garlic.

State of Mouth.—Mucous membrane made white and softened by caustic alkalies and mineral acids (nitric turns it afterwards brown); also by corrosive sublimate and strong carbolic acid. Dry from belladonna, atropine and opium.

Vomiting, Colic, Purging.—In strong irritants, also in arsenic,

antimony (with great depression), digitalis, lead, colocynth, colchicum, and phosphorus.

Nature of the vomit, if any.—Bloody and coffee ground in irritant poisons. Black or dark green, luminous in the dark, with odour of garlic, in phosphorus.

"Emergency" Apparatus.—Every hospital and, indeed, every general practitioner should be provided with emergency apparatus and the necessary antidotes and hypodermic solutions, with directions at hand to aid the memory in case of need.

Messrs. Maw, Son & Thomson have brought out very neat special hypodermic cases with bottles to fit the nozzle of the syringe. The bottles contain Huggett's "permanent hypodermic solutions," for which the following advantages are claimed:—"Readiness for immediate use;" "permanency and non-liability to the slightest decomposition;" "being non-irritating, they are not liable to cause abscesses or set up inflammatory symptoms; their uniform strength and dose, which are guaranteed; the active principles being in solution are without doubt more reliable than medicaments in any other form."

Messrs. Burroughs & Wellcome likewise furnish antidotes in a still more concentrated form. Their soluble compressed tabloids are described as follows by the *Medical Press and Circular*:—"Each little tabloid contains as a vehicle a quarter of a grain of sulphate of sodium, with morphia, atropia, and other alkaloids usually employed for hypodermic medication. The use of sulphate of soda is an advantage over other vehicles, as it promotes absorption without causing pain or irritation, and acts as a disintegrator, forming an almost instantaneous solution with 3 to 5 drops of water." In this form apomorphia, atropine, morphine, &c., may be given. The tabloids may also be taken by the mouth. Certainly they occupy a minimum of space, and are beautifully put up in small glass tubes. The advantages claimed for them are—"Absolute accuracy of dose; ready and entire solubility; compactness and portability; perfect preservation of the drug."

The Stomach-pump.—A necessary instrument to have in readiness is the stomach-pump, or a syphon substitute. There are two kinds of stomach-pump in use—

(1) The best kind has an exit-pipe, provided with a branch at right angles to it close to the syringe; a flute-key arrangement shuts one and opens the other, as required. By alternately opening and closing these while the piston is being worked, fluid may be made either to enter or leave the stomach by the œsophageal tube.

(2) Another kind has a valve preventing entrance at one opening, and exit at the other; so that fluid which enters the syringe by one opening always leaves by the other. By means of adjustable nozzles, the stomach-tube may be attached to either, and so fluid pumped either in or out of the stomach, as required.

To pass the Tube. Smear the tube with olive oil, vaseline, or glycerine; bend its end nearly to a right angle; make the patient open the mouth, and hold the head well back at first. Pass the tube straight to the fauces, avoiding the tongue as much as possible, and gently push it on, directing the patient to "swallow it." The left fore-

finger may be used to guide the tube past the epiglottis when there is much coughing and spasm of the constrictors. As soon as the tube is into the œsophagus, the patient's head must be brought forward, and the tube pushed on with a somewhat upward lift.

Should the patient's jaws be voluntarily or involuntarily locked, considerable force may be required to force them open. A screw-gag is made for the purpose; but failing this, a screw-driver or similar instrument inserted between the teeth will suffice to make a beginning, wedges of wood or cork can then be introduced to keep the ground once gained, and the jaws may be forced open more and more until sufficient room is gained to pass the tube. To prevent its being bitten, either side-gags of wood or cork may be kept in place, or the centrally-perforated one may be used.

Syphon Substitute for Stomach-pump.—All that is really required is an india-rubber tube, which, when passed into the stomach, is long enough to have its end brought below the level of the stomach, so as to produce syphon action. After the tube is in the stomach, fluid must be poured down by a funnel-spout, a syringe, or even from the operator's mouth on an emergency (*Harvey*). When the tube is filled, its outer end must be compressed, and brought lower than the end within the stomach, when the fluid contents of the stomach will flow out, by syphon action. As the exhausting action is gentle, unless a very long tube is used, this method, while equally efficient, is safer than the stomach-pump, as there is less risk of injuring the mucous membrane. One great advantage, moreover, is the impossibility of its going out of order, as it contains no valves.

If desired, it would be easy to attach a T-tube, so as to have a different entrance and exit pipe, as already indicated in the foregoing section on the stomach-pump.

General Treatment.—(1) Get rid of as much poison as may still remain in the system. (2) Neutralise it, and diminish its effects. (3) Give chemical and physiological antidotes, and treat symptoms.

I. For poisons taken by the mouth and not already ejected, give emetics :—

(1) *Sulphate of zinc* 20–30 grs. in half a tumbler of warm water.

(2) *Ipecacuanha* in powder, in ℥ss to ℥i doses in warm water, or 20 min. doses of Vinum Ipecacuanhæ.

(3) *Mustard*, a table-spoonful in a tumbler of warm water.

(4) *Apomorphia*, $\frac{1}{16}$ grain hypodermically; $\frac{1}{8}$ gr. by the mouth (one of the least depressing and most rapid emetics).

(5) *Sulphate of copper*, 10 grs. in warm water (apt to irritate).

(6) *Tepid water*, large draughts of, soapy, greasy, or salt—followed by irritation of the fauces with the finger or a feather.

If necessary, any of these emetics may be repeated once or twice.

Corrosive and the more irritant poisons which damage the mucous membrane of the stomach, contra-indicate emetics, and still more the use of the stomach-pump. However, they usually cause vomiting by their own action. Narcotics, such as morphia and opium (unless in excessive quantities, when it irritates), make vomiting extremely difficult.

Except when contra-indicated as above, wash out the stomach with the stomach-pump in all cases where vomiting cannot be produced, or when any doubt exists as to poison remaining in the stomach after vomiting.

II. Neutralise and dilute *mineral acids* with *alkaline carbonates*, well diluted in water or milk; with lime water; or with chalk, whiting, whitewash, wall plaster, or magnesia (heavy or the heavy carbonate), suspended in milk or water—or with water alone.

Neutralise *alkalies* with *acids*, such as weak acetic, or mineral acids, lime juice, orange or lemon juice.

For both acids and alkalies give demulcents, such as olive oil, milk, thick gruel, white of egg and water or milk, gum and water.

III. Treat collapse by stimulants—*e.g.*, alcohol, as brandy or whisky in doses from ʒi to ʒiv according to circumstances; ammonia (sal-volatile); ether, by mouth or hypodermically (½ to 1 drachm); strong hot coffee (or tea), by mouth or per rectum; strong beef tea or Liebig's extract; and by applying warmth by hot bottles, and warm blankets. Give morphine where there is great pain.

Special Treatment.—In carrying out the directions as indicated in the Table of Treatment for Special Poisons given below, it will be understood that the following *general* methods apply to *all*, unless where statement is made to the contrary.

(1) *Emetics* and stomach-pump.

(2) *Stimulants*, where there is collapse.

(3) *Artificial respiration* in all sudden and extreme cases, especially where the heart beats after respiration has ceased.

(4) *Massage* in the form of superficial effleurage to stimulate the heart, and of muscle-kneading to increase metabolism; this, however, slows the pulse, and increases muscular activity (see under *Massage*).

(5) *Faradic current*, where stimulation is needed (see under *Electricity*).

Where any of the above methods are especially applicable, they are mentioned in the Table. The cases are all supposed to be acute. Drugs marked with a star (*) are to be given hypodermically.

TREATMENT FOR SPECIAL POISONS.

Poison.	Treatment.
Acid, Carbolic, .	$^1/_2$ oz. Epsom, or Glauber's salts, in $^1/_2$ a pint or more of water. Emetics, or stomach-pump, and wash out with the above. White of egg in water. Stimulants and warmth (*Murrell*).
Acid, Oxalic, .	(See detailed Treatment, p. 86).
Acid, Prussic, .	(See detailed Treatment under *hydrocyanic acid*, p. 85).

POISON.	TREATMENT.
Alcohol,	(See detailed Treatment, p. 85).
Arsenic,	1. *Freshly-prepared* hydrated ferric oxide,† in tablespoonful-doses given with a little water. Sub-carbonate of iron. Dialysed iron, followed immediately by common salt. Magnesia. 2. Olive or castor oil, and demulcents. 3. Warmth. Morphine* to allay excessive pain.
Atropia (Belladonna),	1. Tannic acid, hydrate of magnesia, or animal charcoal. 2. Morphine* in large doses, or pilocarpine.*
Chloral,	1. Rouse and stimulate as for opium and morphia poisoning. 2. Strychnine* $\frac{1}{25}$ gr.
Chloroform,	See *anæsthetics*.
Corrosive Sublimate,	1. White of egg, wheat flour or gluten, in water or milk, or milk alone. *Followed* by emetic.
Lead (Acetate),	1. Epsom, or Glauber's salts, or weak sulphuric acid. 2. Milk and white of egg.
Opium or Morphia,	(See p. 85).
Phosphorus,	1. Special emetic, repeated 3 gr. doses of sulphate of copper (or other emetics). 2. Sulphate of copper, afterwards continued in 1 grain doses every $\frac{1}{4}$ of an hour. 3. Magnesia in demulcent drinks. 4. Avoid oils or fats.
Strychnine,	1. Chloroform—the vapour—or administered internally, or ether. 2. Tannic acid. 3. Chloral, paraldehyd, or nitrite of amyl. 4. Curare (?) 5. Artificial respiration.

† Treat tincture of ferric chloride, or strong solution of ferric sulphate, with slight excess of ammonia. Collect precipitate on muslin strainer, and wash out all odour of ammonia (*Wormley*.

The more common Poisons.—Having thus discussed briefly the treatment of cases of poisoning generally, we shall now describe in greater detail the symptoms, diagnosis, and treatment of some of the more common forms met with.

(1) **Opium** (generally taken as laudanum) or **Morphia-poisoning,** begins with cerebral excitement, and soon passes into giddiness, drowsiness, and stupor, succeeded by perfect insensibility. From this state the patient may at first be roused, but he speedily relapses. Afterwards it becomes impossible to rouse him. Pulse at first small, quick, and irregular; respiration hurried; skin warm and moist; all other secretions suspended. When coma sets in, breathing is stertorous; pulse slow and full; pupils at first contracted, towards a fatal termination, dilated. Face placid, pale, and ghastly; eyelids heavy; lips livid. An excessive dose may excite vomiting by its irritant action, otherwise vomiting is not easily produced. In the worst cases muscles are flabby and relaxed; lower jaw drops; pulse is feeble; sphincters are relaxed.

Diagnosis is to be made from alcoholism and from apoplexy with contracted pupils, *i.e.*, in the pons varolii, (*Wilkes*).

Judge by the history and smell of the breath (though alcohol and opium may have been combined). In many cases, correct diagnosis may be impossible, until the stomach-pump reveals the contents of the stomach.

Treatment.—Emetics—or, better, washing out the stomach with the stomach-pump. Preserve the contents of the stomach for after-examination. Rouse the patient by douching the head, slapping with wet towels, tapping on the forehead, faradic current; and force him to walk about. Have relays of assistants, two at a time, to drag him about. Stimulate him by hot coffee. Murrell advises a pint of hot coffee per rectum.

Give atropine, $\frac{1}{100}$ of grain subcutaneously, repeated in a quarter of an hour. Some advocate $\frac{1}{4}$ to $\frac{1}{2}$ grain, repeated in two hours. Patient may be allowed to sleep, when the tendency to intense stupor has passed off.

(2) **Alcohol.**—Acute—When an excessive dose of strong alcohol is taken, or when raw spirits are given to children, the drug acts as a rapid poison, and sometimes kills on the spot. If this does not happen, the patient becomes more or less collapsed; pupils are dilated—often contracted; muscles relaxed. The patient is helpless, becoming soon comatose. If left in this state, he may rapidly sink.

Treatment.—Wash out contents of stomach, or give emetics; stimulate by warmth, and hot coffee per rectum, and rouse by means similar to those recommended for opium-poisoning.

(3) **Hydrocyanic (Prussic) Acid,** and cyanide of potassium, used in photography, produce similar symptoms. Their effect is extremely rapid—from 1 to 2 grains of the pure hydrocyanic acid have proved fatal, and larger doses are certain. In doses insufficient to kill at once, the poison produces insensibility, pallor and swelling of the face, slow laboured respiration; eyes are fixed and glazed; the body becomes rigid—often convulsed.

Treatment.—If there is time, (1) emetics, and stomach-pump; (2) cold affusion to the head, and stimulants; (3) chlorine, by the mouth, in the form of weak solutions of hypochlorite of sodium or lime, or inhaled as gas, which is formed by pouring dilute acetic or hydrochloric acid on either of the above salts; (4) mix 10 grs. sulphate of iron with ℥i tincture of iron and ℥i of water; when this has been taken, give 20 grs. carbonate of potassium in ℥i of water. This renders insoluble 110 min. B. P. acid (*Squire*).

(4) **Oxalic Acid** causes symptoms like those of an irritant poison.

Treatment.—Neutralise with lime in the form of chalk, whiting, or plaster. Avoid soda, potash, or ammonia. Give demulcents; treat collapse, and clear out bowels with castor-oil.

CHAPTER XI.

TRACHEOTOMY. MINOR SURGICAL OPERATIONS.

Contents.—**A. Tracheotomy.**—Requisites for the Operation—The "High" Operation—The "Low" Operation—Caution!—After-Treatment—Intubation of the Larynx—

B. Minor Surgical Operations.—(1) Removal of the Tonsils—(2) Amputation of the Fingers or Toes—(3) Treatment of In-growing Toe-nail—(4) Injection of Spina Bifida—(5) Tapping a Hydrocele—(6) Paracentesis Abdominis—(7) Paracentesis Thoracis—Use of the Aspirator—(8) Air in Veins—(9) Circumcision—(10) Phymosis—(11) Paraphymosis.

A. Tracheotomy.

Tracheotomy is rendered necessary whenever death threatens from laryngeal obstruction which is not at once amenable to other treatment.

Requisites for Tracheotomy.—Chloroform; absorbent wadding-pads for sponging; ligatures; scalpel; dissecting-forceps; Péan or other compression forceps; sharp spoon; director; aneurism needle; scissors; bone forceps (small); syringe with red-rubber catheter attached to suck fluid out of the trachea, tracheotomy tubes.

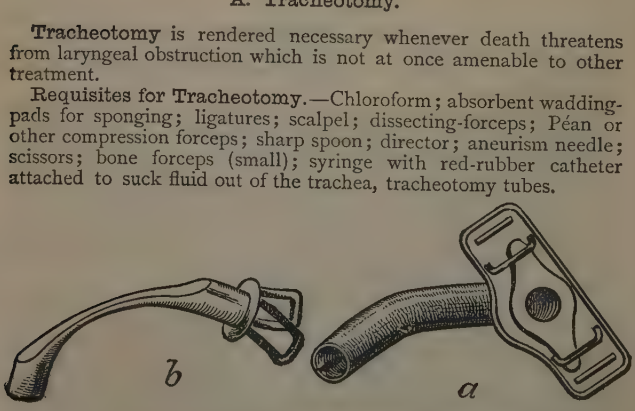


Fig. 35.—R. W. Parker's Tracheotomy Tube; *a*, outer, *b*, inner.

Of these the angled tubes of R. W. Parker (Fig. 35), are much to be preferred on anatomical grounds. The small flange for securing the inner tube had better be removed, when good nursing cannot be had, in case it should prevent the tube from being easily removed if blocked. Durham's pattern is invaluable when the trachea lies deep in the midst of greatly swollen tissues (Fig. 36).

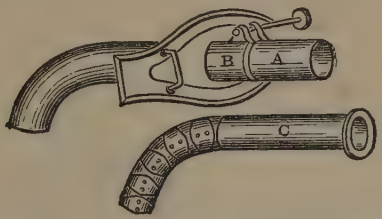


Fig. 36.—Durham's Lobster Tail Tracheotomy Tube. The outer tube (A), can be projected and fixed at any distance from the shield by means of the screw and collar at (B). The inner tube (C), is provided with a jointed tail which enables it to fit the outer tube.

The surgeon generally enters the trachea above the isthmus of the thyroid gland. This is known as the "high" operation. It is more easily accomplished than the "low" operation, below the level of the isthmus, where a more prolonged and difficult procedure is required, since here the trachea lies deeper. Indications for Tracheotomy are presented by the increasing dyspnœa of the patient. There is no time to delay when there is progressive cyanosis, embarrassed respiration, and sinking-in of the intercostal spaces, false ribs, and root of the neck. Chloroform must be given with great care, and very little is required. It is well to roll the patient (especially if a child) in a towel, so that the arms may be secured by the side. The neck and chest should be bared, the neck laid over a pillow and the head curved back so as to pull the windpipe from out the thorax, and increase its cervical extent. The head must be kept perfectly steady and straight. An accurate knowledge of the landmarks of the neck is essential. Where one cannot make out the pomum Adami, as in young children, the more resisting ring of the cricoid cartilage may be felt, when the trachea is traced from below.

First Stage.—The surgeon, standing on the patient's right side, with the palm of his left hand towards the patient's chin, lays his left forefinger on the tip of the thyroid cartilage, while the thumb and middle finger on each side serve to fix the trachea; and makes an incision prolonged from below his finger, through skin and fascia, exactly in the middle line, over the thyroid isthmus, to about an equal distance beyond it. Skin, fat, and fascia, with perhaps a few twigs of the anterior jugular vein, are thus divided. Bleeding points are secured with forceps.

Second Stage.—The surgeon now inserts his finger into the wound

and feels the cricoid cartilage distinctly. It may be necessary to push aside some fat with the handle of the knife in order to do this. He divides now, with a small transverse cut, the fascia over the cricoid, and slips a blunt director underneath it, so that he strips this fascia and the isthmus of the thyroid together with a few venous radicles which run into it, from off the anterior aspect of the trachea. As the trachea in children is rather yielding, and the fascia and isthmus comparatively strong and adherent, it is a good plan to thrust one blade of a compression-forceps under the fascia and isthmus on each side, and divide the tissue between the forceps as far as necessary. In this way, the upper two or three rings of the trachea are bared, and can readily be felt by the finger-tip. The knife is then held short, and plunged into the windpipe for a quarter of an inch with its cutting edge directed upwards, and the incision slightly extended—if need be, even carried through the cricoid. The knife should be then withdrawn, and its handle introduced; this, being rotated transversely to the wound, permits of the ejection of mucus, and acts as a director along which the tube may be introduced.

Should the violent upward movements of the trachea during forced respiration prove troublesome, they may be arrested by inserting the sharp hook to one side of the middle line, or fixation may also be obtained by laying hold of the compression-forceps, which grip the isthmus of the thyroid gland and its fascia. The trachea is then readily incised.

In the "*low*" *operation*, the operator must clearly bear in mind that the chief difficulties are met with as soon as the deep fascia of the neck is entered. The anterior aspect of the trachea below the isthmus is clothed with the inferior laryngeal veins, which may form a complex anastomosis, and here also an abnormal thyroidea ima artery may appear.

As soon as the operator has carried his incision between the depressors of the hyoid, secured the superficial veins, and opened the deep fascia, then his troubles begin. The deeper veins must be separated with the handle of the knife, or grasped with compression-forceps wherever they cross, and the rings of the trachea should be fairly exposed and cleared before they are divided.

Should there be great hæmorrhage with urgent dyspnœa, it is justifiable to open the trachea during the bleeding, delaying first for a few seconds, since the venous bleeding will relieve the engorged right heart. The hæmorrhage and dyspnœa will cease with the first respiratory efforts, and the inspired blood will be mostly expectorated. As far as possible, however, the opening of the trachea should not take place till hæmorrhage is checked. The inspiration of blood is a fruitful source of subsequent pneumonia.

The surgeon must impress on his assistants the importance of keeping the head steady, and must ever bear in mind what misfortunes may attend any deviation of the incision from the middle line. In children, the trachea is soft and yielding, and is readily missed—more especially if the surgeon passes a little to one side or the other.

In very urgent cases, a rapid vertical incision from the apex of the thyroid downwards will expose the crico-thyroid membrane, and by incising this transversely, in order to avoid the crico-thyroid artery, rapid entrance can be obtained to the respiratory tract. Again, it is possible still further to gain room by proceeding next to divide the ring of the cricoid (*Laryngo-tracheotomy*).

Caution!—The operators must always stand aside at the moment that the trachea is opened. Its contents are ejected with much force, and diphtheritic infection is not rarely brought about by direct contact. The tube should be securely tied in, taking care that the tapes do not obstruct the veins of the neck. A little iodoform should be smeared over the raw surfaces, and in the case of diphtheria suitable antiseptic applications used. The inner tube should now be inserted, and the patient put back to bed.

Fig. 37.—Ordinary Tracheotomy Tube. Tapes tied in.

After-treatment.—If all has gone well, the condition is now in marked contrast to the previous distress. The breathing becomes so gentle and easy that it is barely perceptible, and quiet sleep comes on. The future of the case depends largely on careful nursing. There should be two nurses to relieve each other. The patient cannot, without danger, be left for a moment alone. Expectoration must be favoured, and this is to some extent promoted by keeping the atmosphere of the room moist. For this purpose a species of tent may be rigged up around the patient by means of blankets over clothes-screens, and the steam from a couple of bronchitis-kettles carried into it. Towels wrung out of warm carbolic lotion may also be hung up in the room. Uniform temperature of 70° F. should be preserved, and all draughts avoided.

Over the mouth of the tracheotomy tube a double fold of fine gauze, wrung out of warm water, should be laid in order to filter the air, and clots or mucus when ejected should be at once dexterously brushed away by the nurse. Every twenty minutes the

inner tube should be removed and cleansed, if it is not coughed out during the interval. It should be well cleaned in warm carbolic lotion, anointed with a little glycerine and water, the superfluous moisture dried off, and re-inserted. It is customary to clean the lumen with a feather. The feathers used for this purpose should be ordinary poultry wing-feathers, carefully washed in carbolic lotion, and all the loose barbs removed. This is the more necessary when an attempt is made to clear the tube *in situ* in order to stimulate the mucous membrane of the trachea by such means.

Every time the patient awakes, he should be fed. Brandy and beef-tea may be given freely, and digitalis in the event of impending cardiac failure. A close watch should be kept on the urine and condition of the chest.

At the end of twenty-four hours, the one tube may be changed, a duplicate being ready. There is usually little difficulty, but it is well to have a director at hand. By pressing the end of the tube on one side of the tracheal wound, that edge is readily depressed, and the aperture rendered patent, and introduction thus facilitated. The tube is again changed at variable intervals of two or three days, according to the nature of the case. It is finally taken out about the fifth or seventh day; but this again will vary according to circumstances. As soon as the patient can breathe without it, let it be taken out, provided the disease or cause of obstruction has been removed. When spasm develops on its removal, some difficulty may be experienced in getting the patient to use the larynx again for respiration. A new tube should be substituted, with a perforation on its convexity, through which the patient may speak when his finger closes the external opening. He is now encouraged to breathe as well as speak through the normal passages, by blocking the tube with a grooved cork, or by increasing layers of moist muslin, &c. The tube may, of course, be dispensed with entirely, whenever the respiration is perfect. After removal the wound rapidly closes. Emphysema rarely gives rise to trouble. The difficulty due to great swelling of the neck by which the trachea becomes buried, and the tube cannot pass deep enough, is obviated by using Durham's tube.

Should a sudden call for tracheotomy arise from the pressure of a tumour, and one has reason to believe that the obstruction is direct and high in the neck, the "low" operation must be performed. Here again the importance of feeling the trachea, which is often displaced to one side, and also seeing that it is cleared of veins before opening, is to be remembered. In adults, a pair of strong shears, or even bone-pliers, may be required to divide ossified cartilage. In every case of diphtheria, isolation of the patient, and complete disinfection of every article that quits the room, must be practised. The swabs and cloth used for the tubes should be destroyed, and great vigilance exercised over the attentions of friends and relatives.

Intubation of the Larynx.—The propriety of *intubation* of the larynx has been again reintroduced. Macewen of Glasgow has

demonstrated how readily the trachea may tolerate the introduction of a gum-elastic tube resembling a No. 12 catheter, and has recorded successful cases (*Brit. Med. Journ.*, 1880.) Since then, O'Dwyer of New York has invented a series of laryngeal tubes, introductors, and gags for intubation, and a number of authorities have reported gratifying results from the use of his apparatus. Intubation requires practice on the cadaver. The results compare favourably with those gained by tracheotomy, more especially for diphtheria, but the writers have hitherto had no experience of the procedure, and its claims over the major operations are not in this country recognised.

(B.) Minor Surgical Operations.

(1) **Removal of the Tonsils.**—In adults, who have the sense to keep their mouth open, this operation is a simple one for the surgeon, as well as nearly painless for the patient; but where a gag and an anæsthetic are required, the operation is often very troublesome.

In Edinburgh (*a.*) the use of the vulsellum, and curved probe-pointed bistoury is still maintained, while in London and elsewhere (*b.*) the guillotine is employed instead.

(*a.*) *With the Vulsellum.*—The curve probe-pointed bistoury must be wrapped with lint to within an inch of the point. The tongue being kept down with a depressor, and the mouth held well open, the surgeon seizes the prominent tonsil with the vulsellum, and gently draws it towards the middle line. He then cuts off a slice with the bistoury. For a right-handed operator the right tonsil is the most difficult to remove. After grasping this tonsil, the operator may change the vulsellum into his left hand, and crossing his hands cut the tonsil with his right, working from below upwards. The left tonsil is seized with the vulsellum held in the surgeon's left hand, and is cut from above downwards with the knife held in the right hand.

(*b.*) *With the Guillotine.*—When a guillotine is to be used, either Johnstock's or a Physick's instrument, as modified by Morell Mackenzie, may be selected. The latter, from its greater simplicity, is preferable. Mackenzie describes the method of using the guillotine as follows:—"The instrument being ready for use, the hilt is grasped in the right hand, and the aperture in the shank is placed over the tonsil. The surgeon, with the thumb or index finger of the left hand, placed under the patient's jaw, then presses the tonsil inwards, whilst at the same moment with the thumb of his right hand he drives home the blade of his tonsillotome" (*Diseases of Throat and Nose*, vol. i., p. 12).

Usually, after tonsillotomy, the oozing very soon stops. Gargling the throat with cold water is generally enough. When the bleeding threatens to be troublesome, the raw surface may be painted with glycerine and tannic acid, or treated in some of the ways mentioned under the heading *hæmorrhage* (p. 55).

(2) **Amputation of the Fingers or Toes.**—This may be called

for on account of bruising, or, in the case of the fingers, from sloughing following whitlow.

A. Amputation of the Fingers.—From the second phalanx onwards to the point, as much should be left as possible, and in most cases the surgeon's only duty will be to trim the parts, and snip off bone that cannot be covered in by the soft tissues.

In working-men, the first phalanx may sometimes be left with advantage (though this is contrary to the usual teaching), as it moves with the remaining fingers, and helps to strengthen the grasp. A stump of the index-finger, as giving a point of opposition to the thumb, is specially useful. The idea that the first phalanx has no independent power of flexion and extension was long since overthrown by Duchenne. After amputation, it only remains stiff, as the result of sloughing and inflammation.

Amputation at the First or Second interphalangeal Joint is thus performed:—After applying a tourniquet above the wrist, the surgeon completely flexing the two bones, cuts on the distal end of the more proximal one, and thus opens into the joint (Fig. 38). He then cuts a long palmar flap either by dissection from without, or by carrying a narrow-bladed bistoury round the proximal end of the more distal phalanx, and cutting from within outwards. One or two small vessels generally require to be ligatured or twisted.

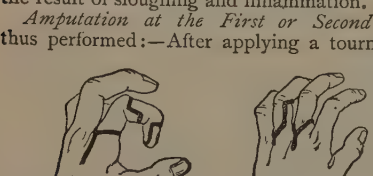


Fig. 38.—Amputation of Fingers.

In Amputation through the Second (or First) Phalanx, a similar long palmar and short dorsal flap is to be adopted, the bone being divided with bone forceps. Some prefer two equal lateral flaps, cut from without.

At the Carpo-metacarpal Joint, the oval or **V**-shaped incision is most frequently adopted. A cicatrix on the palm is to be avoided.

The parts are to be cleansed and purified as usual, a tourniquet applied, and an anæsthetic administered. An assistant steadies the hand, and, if the doomed finger be the **middle** or **ring**-finger, holds the adjacent fingers aside. The surgeon then, holding the finger with his left hand, enters his knife about half an inch above the knuckle (nearer the wrist), and then carrying his knife straight down as far as the joint, next directs it obliquely down the side of the first phalanx to where the web joins the finger, and thence, round the palmar aspect of the finger, on to the dorsum again by a similar route. Having seen that these cuts are down to the bone, he dissects back to the joint; and putting the ligaments on the stretch by bending the finger as required, he divides them, and removes the finger.

Professor Chiene, instead of carrying the oblique cut quite to the

web, when half-way towards it carries the knife down the side of the first phalanx to the first joint. Then, cutting across the palmar aspect of the finger, he returns the knife in a similar way, thus cutting, from the first phalanx, a square palmar flap of skin, which can be turned up and fitted in without trouble. For the **index** or **little finger**, either method of operation is the same; only, as the web is wanting on one side of each finger, the surgeon must, in shaping his flap, cut in to the point to which the web would have reached had it been present—and not short of this, as he is very apt to do. The rules for amputating the **thumb** are the same as those for amputating any of the fingers. From the usefulness of even small pieces of the thumb, as much as possible should always be left of it.

B. Amputation of the Toes.—In the case of the toes, amputation—except in the case of the great toe—is always performed at the metatarso-phalangeal joint. The oval method is also employed here; but it must be noted that the web is further from its corresponding joint in the foot than it is in the hand, and, therefore, the straight part of the incision seems to be longer before the turn is taken towards the web.

Any part of the **Great Toe** may be left with advantage, but if the metatarsal bone be removed, the phalanx is useless, and may as well go too.

In amputating at the metatarso-phalangeal joint of the great toe, it is well to carry the inner incision as far as the end of the first phalanx, to ensure a sufficient covering for the massive head of the metatarsal.

(3) **In-growing toe-nail** is the term given to a condition in which, from the wearing of tight boots, a minute foul irritable ulcer forms beneath the outer margin of the nail of the great toe. There is usually considerable local inflammation, resulting in exuberant granulations which overlap the nail, and the unfortunate sufferer is disabled from walking. In treating this painful affection, it is rarely (if ever) necessary to split the nail and remove the offending portion. In place of such a severe procedure, it is only requisite to thoroughly wash the toe with carbolic lotion 1-20, and pack under the nail over the ulcer with a pointed piece of wood two to three long fibres of lint soaked in an antiseptic. Over all secure with thread a layer of moist lint, covered with guttapercha. Renew this dressing daily, paying particular attention to the packing. After a couple of days, the guttapercha may generally be omitted, and finally, only the packing retained. The patient had better lie up at first in bad cases, and must discard his tight boots.

(4) **Injection of Spina Bifida** with Morton's iodo-glycerine solution.*

Requisites.—Medium-sized trocar and canula; small syringe (glass with vulcanite fittings) to fit canula; iodo-glycerine solution (2 oz.); flexile collodion and brush; probe, lint and cotton wool; a

* Iodine, 10 grs., potass. iodide, 30 grs., glycerine, 1 scruple.

soft clean sponge, lan, needles, fine silk, and fine silver wire (*Morton*).

Operation.—The child is held face downwards. The surgeon punctures the swelling through sound skin if possible, avoiding the exact middle line and any umbilicated point. He next, if necessary, withdraws some fluid and slowly injects the iodo-glycerine solution (from a few min. to 2 drms., according to size, but usually from $\frac{1}{2}$ to 1 drm.)

"Then," says Mr. Morton, "the syringe and canula are withdrawn at the same time, while with thumb and index finger of left hand, I grasp the sac at the punctured aperture, and hold the sides of it together, so that an assistant may apply the collodion there, and when that has been successfully done, about a square inch of lint saturated with collodion is placed over the point of puncture" (fine films of cotton wool, might be better). . . . "When the collodion is completely dried and no oozing perceived, generally a piece of lint is laid over the tumour, and some finely-carded cotton wool around it, while the bandage usually worn by infants is so placed as to keep the protective dressings in position, care being taken not to make the bandage too tight."

Absolute closure is imperative, hence the wire in readiness. Collodion must be re-applied if need be.

In three weeks, the question of re-injection may be considered.

(5) **Tapping a Hydrocele.**—The patient usually stands before the operator, who, for convenience, sits on a chair. The operator begins by recognising by the touch and by the sensations of the patient the position of the testicle, which, though usually behind and below the fluid swelling, may occasionally be found elsewhere. He then grasps the swelling with his left hand, and holding the testicle out of the way, causes the fluid part to bulge forward between his fingers and his thumb; then, holding the trochar and canula in his right hand, he plunges it straight through the skin into the hydrocele. In so doing he avoids any visible vein, and selects a spot below the middle of the swelling. To avoid the risk of passing between the skin and the hydrocele sac, the plunge is made perpendicular to both, but at a place where the fluid separates the testicle from the sac sufficiently to allow the trochar to enter without injuring the testicle. The trochar is then withdrawn, leaving the canula just within the sac, while the surgeon's left hand keeps up steady pressure on its contents. Where no injection of the sac is contemplated, as soon as the fluid has all escaped, the canula is withdrawn, and the aperture covered with collodion. When the sac is to be injected, a syringe fitting the canula is charged with the desired fluid, which is then injected after the contents of the sac have escaped. After removing the canula, the injected fluid is left in the sac, and must finally be distributed over its interior by grasping the scrotum at the point of puncture, and rapidly shaking it for a few seconds.

Of the many fluids advocated, 1–2 drms. of the Edinburgh tincture of iodine has, perhaps, found most favour. In simple

cases of hydrocele, this fluid seldom fails to cure. It causes considerable pain and swelling, however, so that the patient must be kept in bed for three or four days after the operation. After this, the swelling gradually diminishes till it disappears.

A solution of corrosive sublimate recommended by Miller (*Lancet*, 1886) has proved very successful without causing inflammation or laying the patient up; a drachm or two of 1–1,000 is generally sufficient.

Many other fluids have been advocated, and their use has been attended by greater or less success.

(6) **Paracentesis Abdominis** may be required for extreme ascitic distention; the point selected should be in the linea alba 3 or 4 inches above the pubes. The bladder should be empty at the time of the operation. Usually, the patient is supported into the sitting position. To prevent distention of the abdominal veins by the too rapid relief of abdominal pressure, it is well to pass round the abdomen of the patient a broad flannel bandage, which is split in the middle for one end to pass through; the two ends are then drawn upon by an assistant at each side, and the loop round the patient is thus steadily tightened as the fluid escapes.

The danger of syncope from too rapid relief of abdominal pressure, applies equally in large psoas or other intra-abdominal abscesses; where either the evacuation should be partial at first, or compensating abdominal support should be ensured.

A medium-sized trochar and canula should be selected. The surgeon having satisfied himself by percussion that there is no bowel in the way, enters the instrument, and, on withdrawing the trochar, catches the fluid in a vessel held ready to receive it.

A very convenient and gradual mode of withdrawing ascitic fluid is by means of a Southey's tube. One of these, with its tube attached, is inserted into the linea alba, and left there for several hours, until a sufficient escape has taken place.

(7) **Paracentesis Thoracis** may be required for simple pleuritic effusions, when very large, and persistent, or for those of any size which have turned purulent.

As the inspiratory movements of the chest are apt to draw air and with it organisms into the pleural cavity, an ordinary trochar should not be used. For diagnostic purposes a hypodermic needle may be pushed into the pleural cavity, and the syringe filled with the fluid; but when fluid has to be drawn off in quantity, some form of aspirator must be used, *i.e.*, either with an exhausted bottle or with a syphon tube attached.

The part of the chest usually selected is about the level of the angle of the scapula in the mid-axillary line. To avoid the intercostal vessels, the surgeon (where there is room for choice), selects the *lower* part of the intercostal space.

In the use of the Aspirator the following points must be attended to:—

(*a.*) That before and after use the whole apparatus is run through with carbolic acid 1–20, and that before use the needles and canulæ

are steeped in that lotion for ten or fifteen minutes. Take care also that the place of puncture, and operator's fingers, are thoroughly cleansed.

(*b.*) That the exhausting and not the filling end of the syringe is attached to the bottle, when preparing it for use. (The exhausting nozzle is generally lateral).

(*c.*) That the connection between the exhausted bottle and the canula in the abscess or other cavity is not opened until the needle or trochar is withdrawn, and its own stopcock closed.

(*d.*) That on withdrawing the canula, the point where it has entered the skin is closed by having had previously laid upon it a piece of wool saturated in collodion.

Note.—A stimulant should be at hand when the aspirator is used.

(8) **Air in Veins** by the aspiration of the chest is a possible complication of operations on the neck and axilla, when the mouths of wounded veins remain open. The danger is due to the air getting churned up in the right auricle and ventricle, and obstructing the pulmonary circulation, thus causing dyspnœa and, if in sufficient quantity, death. A minute quantity of air in the veins is harmless. The surgeon may be always warned of the accident by the peculiar sucking sound produced.

Treatment consists in instantly putting a wet sponge over the wound, squeezing the chest to expel air already entered, and on cautiously removing the sponge to secure the open mouth of the vein (*Treves*).

(9) **Circumcision,** if for tight prepuce in children (or adults) is performed as follows:—When the child is anæsthetised, put a tight band round the penis and seize the exact *orifice* of the prepuce with catch forceps, and draw it away from the glans. Grasp the tissues in front of the glans with a pair of dressing forceps, and with a knife or scissors cut off the ring of skin which lies in front of the forceps. The outer layer of skin will now retract—the inner layer (sometimes called mucous membrane) next the glans must now be carefully separated with a probe from the glans and turned back so as to expose it. This layer will probably require to be slit up at the upper side (opposite the frænum) and may be trimmed with scissors. The surgeon having thus seen that the glans is thoroughly exposed as far as the corona, looks for and ties any cut vessels that he can see, then stitches with catgut the outer and the reflected portions of the prepuce, and applies a dressing of collodion or Friar's balsam and wool before allowing the blood to return. When this dressing is removed at the end of a week, the part is generally healed. Circumcision in adults may sometimes be required in consequence of venereal disease, where inflammatory phymosis may have rendered the cleansing and other treatment of sores under the prepuce impossible. When the prepuce is inflamed and where palliative treatment has failed or would take too long, the circumcision should be performed as follows:—Instead of grasping and drawing forward the prepuce, the surgeon must begin by inserting a director between the glans penis and the upper part of the prepuce; with

a sharp-pointed curved bistoury, he then slits up both layers of the prepuce as far as the corona. Each half of the prepuce is then grasped with catch forceps and held away from the glans, while the surgeon trims the superfluous prepuce (both layers) with scissors—leaving a margin all round and not touching the frænum. As the parts are generally vascular, allow blood to return, and tie all bleeding points before stitching up. Powder with iodoform, and dress with strips of dry boric lint. Change dressing on second or third day, or at a later date if possible.

(10) **Phymosis**—*i.e.*, where the prepuce cannot be drawn back over the glans penis, may be congenital, or acquired from venereal inflammation. In slight non-inflammatory conditions, the prepuce may be gradually stretched by being drawn back daily. In more severe cases circumcision will be required.

(11) **Paraphymosis** is where the prepuce, after having been drawn behind the glans, cannot be restored to its natural position. The narrow orifice of the prepuce becomes a tight constriction behind the glans, which in turn swells, and so aggravates the mischief. If the condition be not relieved in time, there is a risk of sloughing of the glans, as well as of the prepuce at the point of constriction.

Treatment.—Oil the glans, and try to reduce by grasping the skin of the penis between the fore- and middle-fingers of each hand, while with the thumbs the glans is pressed back. Should this fail, wrap the penis in cotton wool, and then compress it with an elastic bandage for twenty minutes. A second attempt to reduce may now be made, followed by a repetition of the elastic pressure, if need be.

Another method is to grasp the glans with the tips of the thumb and next two fingers, and thus to draw on the penis, then with the fingers of the other hand to try to slide the prepuce over the glans.

Should these manipulations fail the constricting parts must be incised.

CHAPTER XII.

ON BANDAGING

Contents. — Uses of Bandaging — The Roller Bandage—Rules for Bandaging—Typical Cases: How to Bandage (*a.*) the Foot; (*b.*) the Hand—Cautions to be observed in Bandaging—The "Spica" Bandage for (1) the Heel—(2) Knee-joint—(3) Elbow—(4) Groin ("Ascending" Spica)—(5) in Femoral Hernia ("Descending" Spica)—(6) Shoulder—(7) Double Spica of the Groin—(8-9) Single and Double of the Mamma—(10) The Head (how to cover (*a.*) the Forepart; (*b.*) the Posterior Segment; (*c.*) the whole Scalp)—(11) How to Bandage the Fingers.

THE bandage is one of the most ancient forms of surgical apparatus, the simplest and most convenient. It is employed under varying

circumstances and for many purposes, but its chief use is to give rest and support. With it one may retain splints and dressings, prevent and cure swelling, or check bleeding. Impregnated with some stiffening agent such as plaster of Paris, it gives us a rigid material most useful in the treatment of fractures and of other lesions.

Simplest Form of Bandage.—Inasmuch as the proper application of a bandage requires an appreciation of certain *principles* necessary to attain the end in view, it is well to study the most elementary and fundamental form at length; this is the **roller-bandage.** It is intended in what follows that the student should apply the bandage as he reads, and carry out all the manipulations as they are described.

The Roller-bandage, as provided in hospital, is usually made as follows:—Procure 6 yards of calico, about 1 yard in width, and remove the selvedges. Mark off with scissors short strips of the desired breadth; then grasp the alternate strips gathered in two separate bunches, and pull in opposite directions. From such a web one may thus obtain—

16 rollers, 2½ inches broad; suitable for the head and upper limbs.
12 ,, 3 ,, ,, lower limbs.
8 ,, 4 ,, ,, trunk.

These are frequently known as eights, twelves, and sixteens. The strips must now be rolled. Start at one end as if making a cigarette with the fingers and thumb. Lay the small roll on a flat surface, such as a table, or on the thigh; steady the loose strip with the left hand; press the right palm firmly against the roll and run it down over the strip, which will coil round, and we get a firm uniformly wound bandage. Or, again, the small initial roll may be held between the forefinger and thumb of each hand, and rolled with the fingers as shown in Fig. 39.

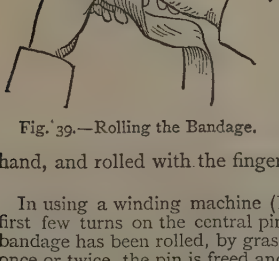


Fig. 39.—Rolling the Bandage.

In using a winding machine (Fig. 40), care must be taken that the first few turns on the central pin are not very tight, so that when the bandage has been rolled, by grasping it firmly and reversing the handle once or twice, the pin is freed and may readily be withdrawn.

To finish off the bandage, a few stray threads from the margin may be wound around the roll to keep it together, and the frayed edges trimmed.

To apply the bandage, select the size required, break the encircling threads, and liberate the free end or "tail." The compact roll is known as the "head," and we may further recognise an anterior and posterior surface, an upper and a lower margin.

We may now look at the surface which we are about to bandage. Note that it is always curvilinear. It may be resolved into a series

of cones, with bases or apices opposed, with here and there perhaps a short cylinder. In the lower limb, for example, we may trace a cone as we pass from the toes to the heel, another from the heel to

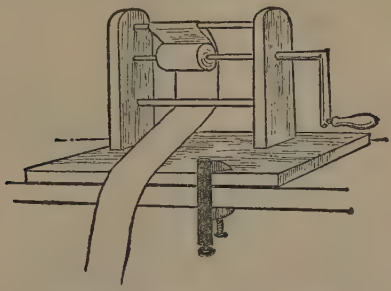


Fig. 40.—Machine for Rolling Bandages.

the ankle; at the ankle, we may meet with a short cylinder, which is continued upwards as a cone gradually expanding at the calf of the leg; and so on.

Rules for Bandaging.—General rules to guide one in bandaging may be laid down as follows:—

(1) Fix the bandage.

(2) Bandage from below upwards, and from within outwards, over the *front* of the limb.

(3) Use equable pressure throughout.

(4) Let each succeeding turn overlap two-thirds of its predecessor.

(5) Keep all the margins parallel, and let the crossings and reverses be in one line, and rather towards the outer aspect of the limb.

(6) End by fixing the bandage securely.

Typical Cases—(*a.*) How to Bandage the Foot.—Let us exemplify this by covering in the left leg. Stand in front of the patient, who extends his foot. Grasping the roller in the right hand, lay the tail against the ball of the great toe. The bandage must now be carried in a loop around the ankle, and back again to the point from which it started (Fig. 41, A). Therefore, let the head roll on the dorsum of the foot to the outer malleolus, behind the ankle to the inner malleolus, across the dorsum and the first turn to the ball of the little toe, and beneath the sole to the great toe, thus making a double loop, or figure-of-eight, and fixing the end. We now proceed to cover in the limb by taking a complete turn over the dorsum of the foot at the roots of the toes, ascending on the inside with a gentle spiral. We cannot, however, continue this simple spiral, otherwise the bandage would stray and portions of the foot would remain uncovered. The spiral is not suitable for cones, and in order to atone, as it were, for

the increasing diameter, since our bandage is of uniform breadth, it is necessary to employ a reverse (Fig. 41, B). To make a reverse, hold the head lightly in the right hand—we may note that the *anterior* surface of the bandage is at present exposed—free about 3 inches of tail, steady the lower margin of the bandage with the

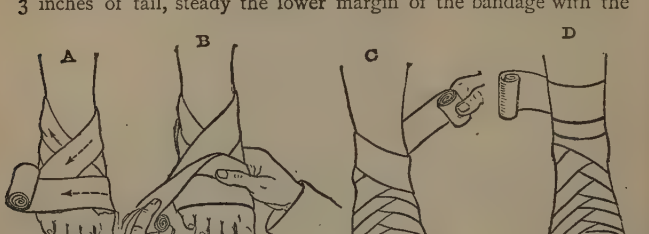


Fig. 41.—Bandaging the Foot.—(A) Fixing; (B) Reversing; (C) Figure-of-Eight; (D) Complete.

left forefinger against the dorsum of the foot rather to the outer side of the middle line; pronate, and circumduct the head by sweeping it to the inner aspect of the foot over the forefinger, and then outwards, so that a fold forms. The *posterior* surface of the bandage is now exposed, the upper margin points to the toes, and the head no longer rolls on the foot, but requires to be unwound, as we carry the roller under the sole upwards with a gentle spiral ascent. As the bandage passes from the outside to the inside of the limb, it is received by the left hand, and transferred again to the right hand. The bandage now reaches the point of the former reverse, but at a higher level, overlapping two-thirds of the last turn, and a second reverse is required. Again we repeat our former manœuvre, fixing the margin in the same line as our previous fold. We may note that now we bring the *anterior* aspect of the roller into view, and the bandage again rolls. In this way, we make two or three reverses, alternately rolling and unwinding the bandage, exposing alternately its anterior and posterior surfaces. As we mount the instep, however, it will be found that the bandage no longer lies smoothly, that is because we approach the junction of two cones at the heel, and wherever that occurs the figure-of-eight is required (Fig. 41, C). In place of reversing, we pass round the outer malleolus, and so come down from behind the inner malleolus, over the dorsum, under the sole, ascend on the inner side, cross the dorsum, and so back to the internal malleolus. This is repeated until such time as we reach the ankle, when, as we now meet a simple cylinder, two or three spirals are available. The bandage once more shows by its tendency to stray that we are at the cone of the calf, and again reverses are employed. To finish the bandage, a figure-of-eight turn is made

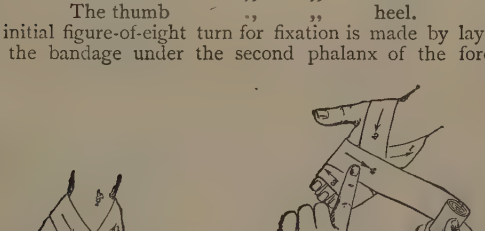
around the upper part of the calf, and the tail of the bandage is fixed at the last reverse by means of a pin inserted parallel to its margins (Fig. 41, D).

We may here observe that the simple *spiral* is used in the case of cylinders, the *reverse* when covering cones, and the *figure-of-eight* at the basal junction of cones.

Typical Cases—(*b.*) How to Bandage the Hand.—Just as we bandaged the lower extremity, so may we bandage the upper. The arm should be extended and supine, so that the palmar aspect of the hand occupies a position similar to the plantar of the foot. Small oblong pads of dry cotton wool (preferably charged with some non-irritating antiseptic) are laid between the fingers so that the skin secretions may be absorbed. It is of cardinal importance that the skin-surfaces should always be kept apart, or else chafing will certainly ensue.

The hand now corresponds to the foot.			
The forefinger	,,	,,	great toe.
The little finger	,,	,,	little toe.
The wrist	,,	,,	ankle.
The thumb	,,	,,	heel.

The initial figure-of-eight turn for fixation is made by laying the tail of the bandage under the second phalanx of the forefinger,



a *b*

Fig. 42.—Bandaging the Hand.—*a*, Fixing; *b*, Reversing.

looping round the wrist, descending to the terminal phalanx of the little finger, and so on in every respect just as we bandaged the foot. As the heel was left exposed, so also do we leave the thumb free.

In bandaging the left limbs, our manipulations are chiefly carried out with the right hand; but in the case of the right limb the left hand is employed, a task which, at first somewhat awkward to accomplish, becomes easy with practice.

Cautions!—It is of the utmost importance that there should never be any constriction of the limb. The bandage should exert uniform pressure with ease and comfort to the patient. It is necessary to increase the tension somewhat with the circumference of the limb. In any case, the condition of the exposed digits affords a sure guide

to the state of the circulation. In children especially, the utmost care is requisite, for their soft tissues yield readily and with a moderate amount of force constriction may be caused, the circulation

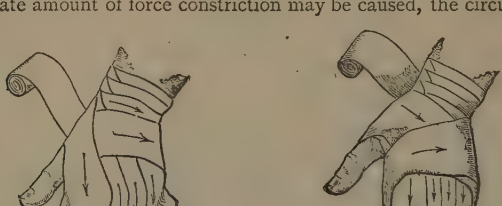


Fig. 43.—Bandaging the Closed Fist.—*a*, Figure-of-eight Loops; *b*, Finishing.

impeded, and gangrene, as the result of tight and careless bandaging, ensue. The slightest œdema or discoloration is a warning, which we dare not neglect.

B. Special Forms of Bandage: The Spica.

This is simply a figure-of-eight, and the term "spica" refers to the cross-like arrangement seen at the intersections of the figure-of-eight, which bear a certain resemblance to the arrangement of glumes in a spikelet of wheat. (From the Lat. *spica*, an ear or spike of corn.)

In order to cover in large prominences, such as the heel, the bent knee, and elbow, a modification of the figure-of-eight, known as the "Divergent Spica," is made use of.

(1) *Divergent Spica for the Heel.*—Lay the tail against the external malleolus, and carry the roller under the sole to the internal

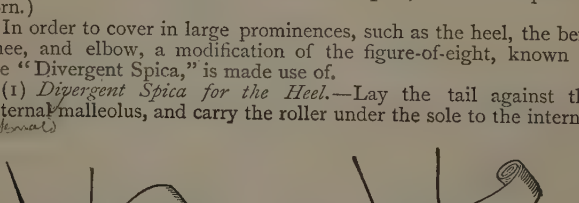


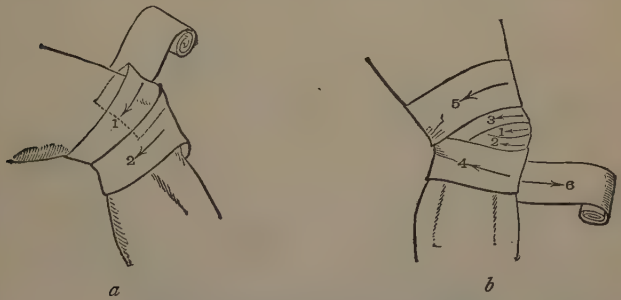
Fig. 44.—Divergent Spica of the Heel.

malleolus, and thence from within outwards over the dorsum to the point from which you started, thus fixing the bandage. Now

travel over the tip of the heel, so that its most projecting part is embraced by the tense middle portion of the turn, and the two margins are left loose. Pass over the dorsum and again round the heel, diverging from the tip, so as to fix the lower loose margin; the next turn, passing round the heel at a higher level, includes the upper loose margin. In this way the middle third of the first turn over the heel is exposed, and the succeeding turns confine and overlap the loose margins of their predecessors. The bandage may be carried over the forepart of the foot and up the leg, if necessary. Such a bandage serves to retain dressings, &c., but is not frequently required.

(2) *Divergent Spica of the Knee-Joint.*—The limb must be slightly flexed.

Lay the tail against the inner condyle. Pass the roller over the front of the patella, and outer condyle back to the starting point. The second turn travels in a similar direction, but at a lower level, so that the lower loose margin of the first turn is fixed, and in a similar way the third turn secures the upper loose margin. A transverse



a *b*

Fig. 45.—Divergent Spica of the Knee-Joint.

elliptical series of margins, which imbricate, are thus seen in front of the knee-joint, and a limited range of movement is allowed, as the layers glide easily on each other like scale-armour as the limb swings to and fro. Such a bandage may be useful in giving support to a joint which has been inflamed. It specially protects the posterior and lateral aspects of the joint; the anterior does not require such covering, owing to the patella. In cases of varicose veins, an ordinary bandage carried from below upwards, and over the knee, will allow the patient to walk freely, if the divergent spica be employed.

(3) *Divergent Spica of the Elbow* differs in no respect from that of the knee. It is employed in cases where we keep the arm at rest in the flexed position, as after fractures and injuries to the joint.

(4) *Spica of the Groin: the Ascending Spica.*—This is simply a

figure-of-eight used to confine dressings or to retain a rupture. There are two forms, the "ascending" and the "descending." To form the first loop of the ascending spica (Fig. 46), lay the tail over the external abdominal ring of the ruptured side, and carry the roller upwards and outwards around the pelvis, midway between the great trochanter and the crest of the ilium back to the starting-point, where it crosses the tail. To form the second loop carry the bandage over the outer aspect of the thigh round into the perinæum, and back to the starting-point again. In this way a series of crossings are produced, each higher than the preceding one, with which we may exert pressure all along the line of the inguinal canal. Beneath each crossing a small flat compress of lint may be laid so as to afford sufficient pressure.

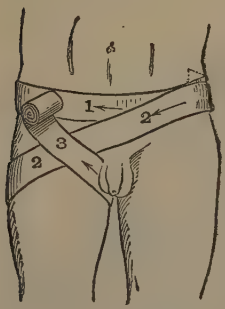


Fig. 46.—Spica of the Groin —Ascending Form.

(5) *In Femoral Hernia.—The descending spica* is preferred in cases of femoral hernia (Fig. 47). Lay the tail over the saphenous opening, and carry the roller over the symphysis and round the pelvis at the same level as before. As the first loop is completed, the bandage is next passed downwards into the perinæum and outwards round

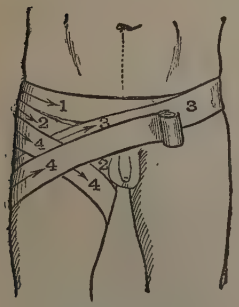


Fig. 47.—Spica of the Groin— Descending Form.

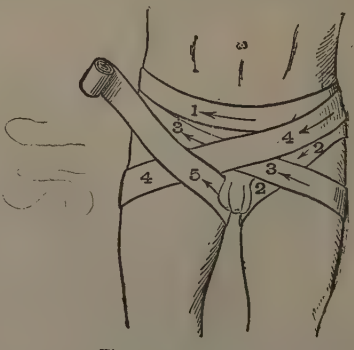


Fig. 48.—Double Spica of the Groin.

the thigh back to the starting-point; thus the second loop is finished, and the succeeding turns follow in the same manner, each lower than the preceding one. It will be observed that, as regards the successive crossings, the line of support in each case agrees with the

direction of taxis used in reducing the hernia, viz., from below upwards, in the first case—from above downwards, in the second.

(6) *Spica of the Shoulder* is practically the continuation upwards of the bandage of the upper extremity. The larger loop of the figure-of-eight is formed by passing from the highest limit of the upper arm over the shoulder and behind the chest, under the opposite axilla, and back again over the shoulder. As the smaller loop is formed by carrying a turn round the arm, the crossing takes place in the line of the last reversal. In this manner, by continued overlapping turns, the whole shoulder may be covered in. We do not carry the bandage around the neck, since it is so freely moveable; but we select the chest instead, much in the same way as we take the fixed pelvis when applying the spica of the groin, in preference to the mobile abdomen. Just as the rise and fall of the abdominal parietes would vary the tension of the bandage, so also would the movements of the neck relax or tighten the figures-of-eight, and the bandage would not be secure.

(7) *Double Spica of the Groin* is of little practical importance, but is sometimes used to retain dressings. The diagram (Fig. 48) explains itself. There are three crossings produced, one at each groin, and one in the middle line. This bandage might be used in

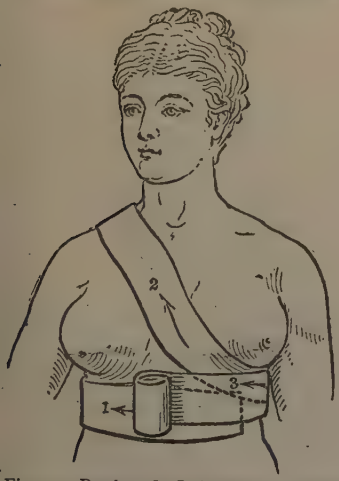


Fig. 49.—Bandage for Left Mamma, begun.

Fig. 50.—Double Spica for Left Mamma

cases where there was an *inguinal hernia* on one side, a *femoral* on the other. For double herniæ of the *same* kind, it is better to apply a separate single roller to each.

(8) *Single Spica of the Mamma* (Left).—Lay the tail against the

left side, and take a complete circle round the anterior aspect of the waist, travelling towards the mammæ, so that the roller confines the tail. Support the left breast gently with one hand, while with the other carry the bandage from below upwards; withdrawing the hand, the bandage takes its place, and the second loop is completed as the roller travels to the right shoulder, and obliquely over the back to the point from which the ascending loop started. A series of such figures-of-eight may be superimposed as required.

(9) *Double Spica of the Mamma*, may be compared with the double spica of the groin. The one breast is supported from below upwards, the other from above downwards, just as in the two forms of hernia. Where both mammæ are inflamed, separate bandages for each are more useful (Fig. 50).

(10) **How to Bandage the Head.**—The divergent spica is the typical bandage for the head. Owing to the tendency of the figure-of-eight loops to slip on this part of the body, it is important that the initial and concluding turns should be secure, and that all should have a mutual dependence. Three main series of loops, at right angles to each other, are employed. (1) *One, horizontal* in direction, passing above the level of the ears, grips the cranium firmly (Fig. 51)

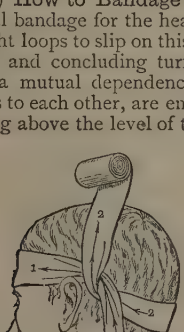


Fig. 51.—Knotted Bandage of the Head—beginning.

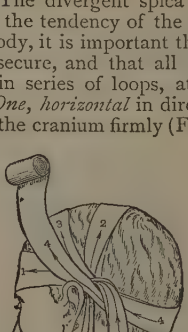


Fig. 52.—Formation of Divergent Spica over Anterior Part of Head.

between the frontal eminences and superciliary ridges anteriorly, and below the occipital protuberance posteriorly. (2) *A second series, coronal*, runs from the vertex below the chin, passing behind and sometimes in front of the ears. *A third final turn* courses over the vertex *from behind* forwards. At the various crossings, pins should be inserted, or all may be basted together with a needle and thread.

To cover in the Fore Part of the Head, proceed as follows:—Grasp the loose tail in one hand, and carry the roller around the head to form the horizontal turn. Pass the roller beneath the loose end, carry it at right angles to the first turn, and so form the

coronal circle. The scalp is thus divided into an anterior and a posterior segment; one may, therefore, cover each of the exposed portions with a separate divergent spica, making use of the loose tail as a fixed point, around which our successive turns play, as seen in the diagram (Fig. 51). Finally, by carrying the bandage from behind forwards we complete all; for to this concluding turn the others are all pinned, and so secured.

The posterior segment of the scalp is more difficult to cover in. By giving an increased obliquity to some of the loops, by carrying

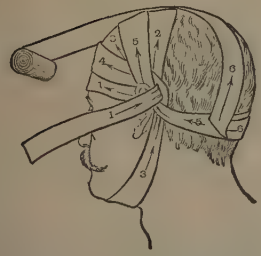


Fig. 53.—Postero-Anterior Turn—Conclusion of Knotted Bandage.

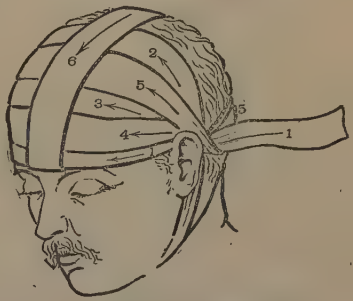


Fig. 54.—Completed Knotted Bandage.

the turns around the forehead, under the chin, and, perhaps in front of the ears—according to the individual peculiarities of the head in question—a good result may be obtained. Should the shape of the skull prevent the application of such a bandage, or if it be desirable to cover in the whole scalp, the *capeline bandage or double-headed roller* may be used as follows:—

To Cover in the whole Scalp.—Fasten two rollers together as shown in Fig. 55. Let one be rather longer than the other. The larger roll should always circle round the head, the smaller should after the first turn travel backwards and forwards. The horizontal turns serve to fix the vertical, which form a divergent spica. Stand behind the patient with the larger roller in the left hand, the smaller in the right. Lay the bandage against the root of the nose, and carry the rollers horizontally directly backwards. Change hands at the occiput, and let the horizontal turn cover in the vertical one, which should now be carried forwards right over the nose, at the root of which it is fixed by the circling horizontal turn. The vertical turn is now carried back again to the occiput, slightly to one side of the middle line, and is once more fixed posteriorly by the horizontal turn —and so on. Care must be taken not to diverge too rapidly, and to come well down to the glabella in front and below the occiput behind at every turn. In this way, a most firm and secure bandage is obtained, which defies every attempt to take it down. It is, however,

somewhat heating, and the superimposed circling turns are rather constricting, and apt to induce headache. Gauze bandages do not give rise to this objection.

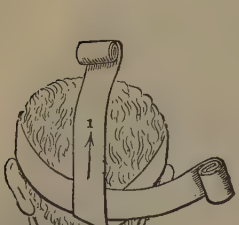


Fig. 55.—Beginning the Capeline Bandage, viewed from behind.

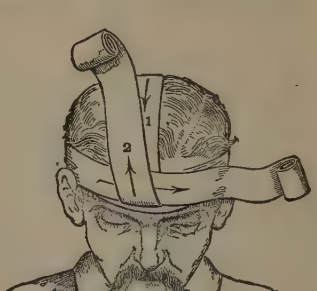


Fig. 56.—Capeline Bandage, from the front.

The divergent spica may be used for the head with a *single* roller, if one have assistance. A couple of horizontal turns to fix the bandage are made. The roller then passes at right angles from occiput to glabella, and at each angle is fixed by the assistant's fingers, which must be firmly applied, and which will serve to confine the extremities of each turn of the divergent spica. Finally, a concluding couple of turns replace the fingers, secure the ends of the bandage of the vault, and safety-pins, transfixing all the folds, are inserted in front and behind.

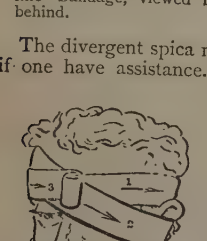


Fig. 57.—Bandaging the Eye.

(11) *How to Bandage a Stump.*—In a similar way, one may bandage a *stump*. Here the thumb and fingers serve to grasp the ends of the divergent spica, which passes over the face of the stump. Final circular turns and pins hold all together.

How to Bandage the Fingers.—As a rule, the digits receive sufficient support with the ordinary bandage for the hand. Small dressings may be secured with a few turns of worsted. If thought necessary, a narrow bandage for the prevention of œdema is put on by taking a turn around the wrist, passing to the tip of the finger in question, gently spiraling to the web, and so back to the wrist. One may also go from finger to finger, taking a turn round the wrist between each. For the **thumb**, a figure-of-eight is desirable.

CHAPTER XIII.

BANDAGING—*Continued.*

Contents.—Looped Bandages.—(1) For the Heel—(2) Looped and Reversed Bandage for Varicose Veins—(3) Bandage for use after Excision of the Breast—(4) For the Perinæum—"Lithotomy" Position—The "Clove Hitch:" How to make it—The T-Bandage —The Four-Tailed—The Many-Tailed Bandage—The Triangular Handkerchief — The Square Handkerchief — The Suspensory Bandage, &c.

Looped Bandages.

(1) *Looped Bandage for the Heel* (*Right Foot*).—Having covered in the forepart of the foot, and ascended to the instep (as formerly described), carry the roller over the tip of the heel back to the instep,

a

Fig. 58.—Looped Bandages for the Heel.

and dip down to the sole. Now carry the bandage round the side of the heel under the malleolus, then to the tendo Achilles, and back to the instep. Repeat looping round the internal malleolus in the reverse direction.

(2) *Looped and Reversed Bandage.*—This form was, previous to the introduction of Martin's rubber-bandage, a favourite in the treatment of varicose veins of the leg. It gives great support, and clings with such tenacity that it does not readily become loose, or come down while the patient walks. Let us imagine that the right hand or foot has been already covered in, as formerly described, and that the few spiral turns usually made at the wrist or ankle have been completed. In place then of making a reverse at once, the spiral is continued to the posterior aspect of the limb. Here the surgeon, fixing the lower margin with the right hand, the left hand supinating, executes the reverse, and the roller is made to loop downwards round the back over the last turn. It is thus looped around the limb, and

ascends parallel with the first turn, crossing the upper part of the second. Reaching the back of the limb, the wandering spiral is brought back with a reverse similar to the last, and again we loop

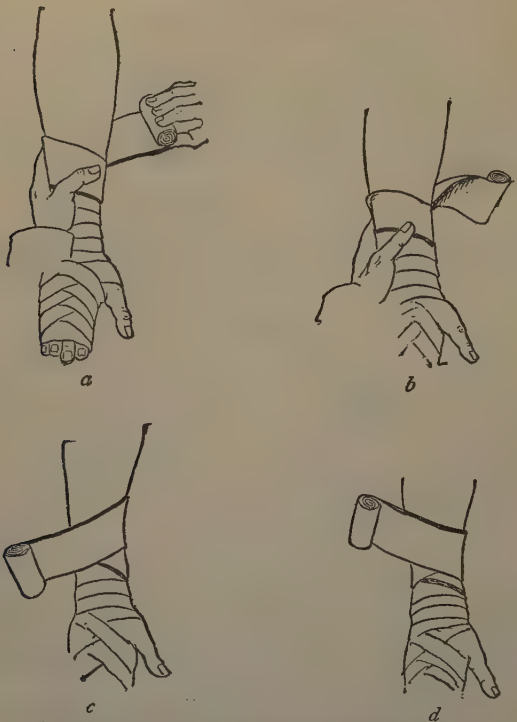


Fig. 59.—Looped and Reversed Bandage for the Forearm.

down, around, up, and reverse. Whenever we reach the back of the limb ascending, a reverse is required. Sweep the bandage around the limb with boldness. Never mind how far it seems to stray in making the ascent, since the reverse will bring it back again with ease. As usual, let all the margins be parallel, and only expose one-third of each turn.

(3) *Bandage for dressing after Excision of the Breast* (*Right*).—Apply the dressing, cover the sound breast with antiseptic wool. Lay the tail of the bandage over the sound breast. Ask the patient

to bend the knees and arch the back, and sweep the bandage underneath the back to the starting point. Again carry the bandage

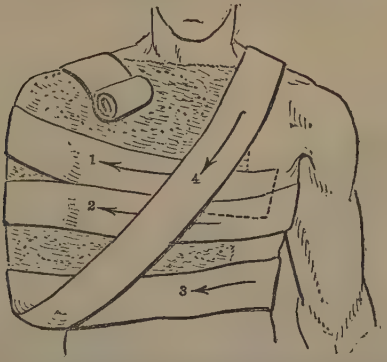


Fig. 60.—Bandage for Securing Dressings after Excision of the Mamma, or for Fixing the Upper Limb—First Part.

around and to the front at a *lower* level, so as to confine the margin of the dressing. Pass posteriorly up to and over the sound shoulder,

Fig. 61.—Bandage for Securing Dressings, and for Fixing the Upper Limb—Complete.

come down in front under the elbow, and up behind the arm over the right shoulder. Now loop in front, obliquely downwards,

across the chest; and upwards, posteriorly, to the left shoulder. Descend in front of the arm under the elbow, over the back to the right shoulder and down over the hand. Pins must be inserted at the crossings, or the whole basted.

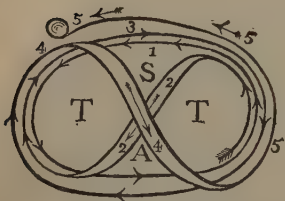


Fig. 62.—Diagram of Looped Bandage of Perinæum seen from below.—T, Thighs; S, Scrotal Triangle; A, Anal Triangle.

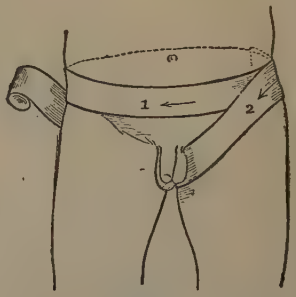


Fig. 63.—Looped Bandage for Perinæum—First Turns.

(4) *Looped Bandage for the Perinæum.*—This is used in the application of dressings to the scrotum, &c. Lay the tail midway between the left anterior superior spine and the great trochanter. Sweep round the pelvis at the same level back to the starting-point; thus fixing the bandage. Dip down into the perinæum over the left

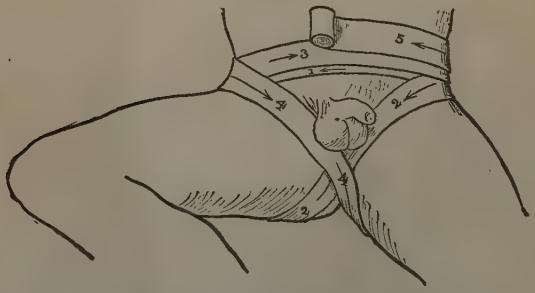


Fig. 64.—Looped Bandage for Perinæum—Crossing of the Loops.

groin; pass in front of the anus, and carry the bandage upwards in the line of the right gluteal fold to the hollow between the right anterior superior spine and great trochanter. Sweep round the pelvis towards the left, and back to the right side again. Dip into the perinæum over the right groin, up over the left buttock;

circle round towards the right, and begin once more at the left side (Fig. 64).

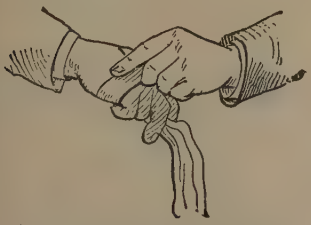


Fig. 65.—Forming Loop for Lithotomy Position.

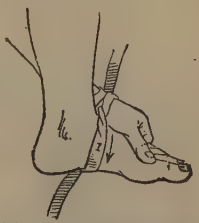


Fig. 66.—Lithotomy Position—Fixing Hand to Foot.

The "Lithotomy" Position.—For operations on the perinæum, the well-known "lithotomy" position is the most suitable. The patient, laid on his back and deeply under the influence of an anæsthetic, is pulled down on the table till his breech just projects beyond it. A clove-hitch (*see below*) is secured to each wrist, the thighs are flexed on the abdomen, and the legs on the thighs; and now, by seizing the free ends of the clove-hitch, the wrist is brought down to lie opposite the external malleolus, and secured to the foot by firm figure-of-eight loops, as in Figs. 66, 67. During the operation, care must be taken to maintain the pelvis firm and square, with the thighs in the same position on each side. The assistant secures the legs by holding the sole with both hands, the knee resting in the middle.

Fig. 67.—Lithotomy Position—Hand and Foot Fixed.

The "Clove-Hitch" is made as follows:—Grasp the bandage, &c., with the left hand supine and the right prone, as indicated in the figure, now pronate and supinate the two hands respectively (Figs. 68, 69), and slide both loops on to the left hand (Fig. 70).

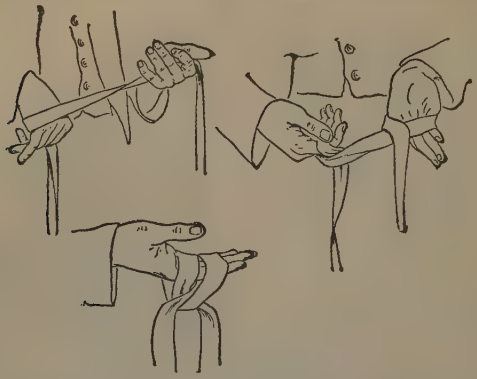
Another plan is to make two successive loops in the same direction, and place one behind the other.

(5) *The* T-*Bandage* is employed for the perinæum. The horizontal limb passes around the pelvis; the vertical limb—single, double, or split—serves to retain rectal dressings, with the advantage that the split tails may come up on each side of the scrotum.

(6) *The Four-tailed Bandage* is used in fracture of the lower jaw.

(7) *The Many-tailed Bandage* (or bandage of Scultetus), consists of a central strip or backbone of bandage, to which some eighteen shorter imbricated strips (Fig. 71) are stitched at right angles. The limb is laid on the bandage so that its axis corresponds with the

central strip, and, beginning at the periphery, the strips are gently and firmly folded over as seen in the diagram. A pin at each side, securing the two last strips to their predecessors, serves to



Figs. 68, 69, 70.—Forming the Clove-Hitch.

fasten all safely. By taking out the pins, and flinging the tails right and left, the whole bandage is readily taken down, and a fresh dressing having been applied, the strips may once more be folded over so that the limb need not be disturbed in the least. For burns and painful wounds, such a bandage is to be commended.

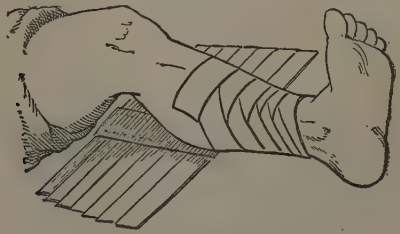
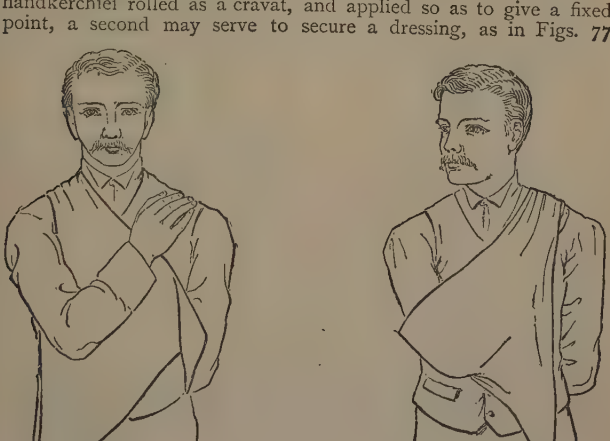


Fig. 71.—Many-Tailed Bandage.

(8) *The Triangular Handkerchief.*—The use of slings, in place of the bandage, has been revived in recent years. Esmarch of Kiel has especially drawn attention to their use in military surgery. The handkerchief possesses many advantages. It can be speedily and easily applied. It is available for many varied purposes, and is readily washed. In using the sling, the base of the triangle should always be applied to the part which requires support. Thus we see

in Figs. 73 and 74, the elbow and wrist suspended. The loose end may be tucked up, and for neatness, secured with a safety-pin; but on no account should the pin bear any weight—that is all borne by the longer ends of the handkerchief, which should be tied in a reef-knot.

Fig. 79 shows the sling adapted to retain dressings on the head. In a similar way, we may cover in the hand or foot. With one handkerchief rolled as a cravat, and applied so as to give a fixed point, a second may serve to secure a dressing, as in Figs. 77



Figs. 72 and 73.—Triangular Handkerchief supporting the Elbow, *a* and *b*.

and 78, where the shoulder and hip are seen covered in. Such examples may suffice.

(9) *The Square Handkerchief.*—A good head-dressing may be formed from a square handkerchief (40 in. square), folded across 4 inches beyond its middle line, and laid over the head, as represented on the left side of Fig. 80. The two *outer* corners, that is, those of the smaller portion of the napkin, are first carried beneath the inner corners, and tied under the chin. The edge of the inner and larger portion is then turned up over the forehead, and its corners are secured at the nape of the neck. A four-tailed handkerchief (Fig. 81), and one with six tails, have also been used for a similar purpose.

(10) *Suspensory Bandage.*—This refers to the suspension of the testicles, and may be called for in orchitis and epididymitis, variocele, or when the skin of the scrotum is ulcerated or eczematous.

Fig. 74.—Triangular Handkerchief supporting the Elbow, *c*.

Fig. 75.—Triangular Handkerchief supporting the Forearm.

Fig. 76.—Triangular Handkerchief supporting the Forearm from the Opposite Shoulder, *after Esmarch*.

Fig. 77.—Dressing for the Shoulder with Handkerchiefs, *after Esmarch*.

An open net-work bag to hold the testicle, attached to a waist-band, is sold by chemists and instrument-makers. Failing this, an extempore support may be made from a triangular piece of cloth.

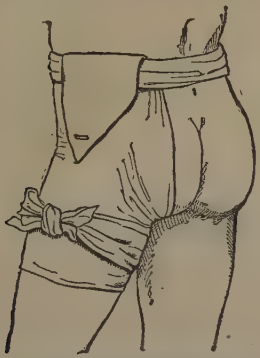


Fig. 78.—Dressing the Thigh with Handkerchiefs, *after Esmarch.*

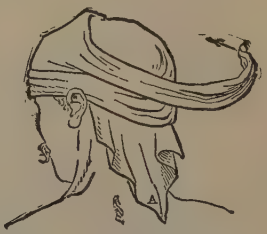


Fig. 79.—Triangular Handkerchief for the Head. The dependant Angle is to be turned up and pinned over the Vertex.

A waist-band is first applied, and the long ends of the triangular cloth are fixed to it. The straight edge of the cloth is brought under the scrotum, and the point carried over it and fixed above.

A pair of well-fitting bathing-drawers, padded with cotton wool,

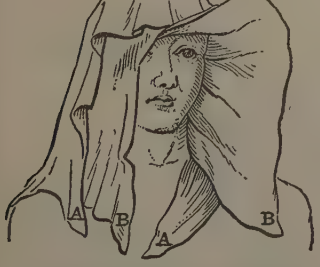


Fig. 80.—The Square Handkerchief for the Head.

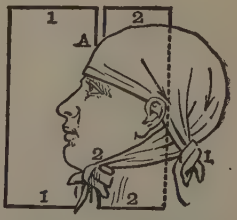


Fig. 81.—Square Handkerchief used for the Head, after splitting as at A.

if necessary, make an excellent suspensory bandage. Some use a T-bandage, the vertical part of which (of broad flannel) is carried from the back up over the scrotum, so as to raise it. An aperture may be cut for the penis to allow of micturition, without the necessity of taking the bandage down.

Strapping the Testis is frequently required to remove swelling

after acute orchitis or epididymitis. Some lint, and about a dozen strips of sticking-plaster, ½-in. wide, and long enough to encircle the testis in both directions, are required.

The affected testis is first isolated in the scrotum, by a circle of lint at its upper part, over which is a layer of plaster. The organ cannot now slip away, and it must be covered with successive layers of plaster, longitudinal and circular.

In a few days the swelling by subsiding will have left the plaster loose when it must be applied again.

CHAPTER XIV.

ON FRACTURES.

Contents.—**A. Fractures in General**—Diagnosis—Importance of knowing the History of an Injury—Examination of the Injury—Setting of the Fracture—Essentials of Treatment—Prognosis—Materials for Splints—Passive Motion—Union and Non-Union—"Greenstick" Fracture—"Dislocation" and "Fracture," distinction between.

B. Special Fractures of the Upper Extremity—Treatment of Fracture of (1) the Clavicle; (2) of the Body of the Scapula; (3) of the Humerus; (4) of the Forearm; (5) of the Olecranon; (6) of the Radius above the Wrist (Colles' Fracture); (7) of the Metacarpals and Phalanges.

A. Fractures in General.

THERE are comparatively few of the surgical ailments which fall into the hands of the general practitioner of greater importance than **Fractures.** The future usefulness of a limb fractured depends largely on the diagnosis and on the consequent treatment. Moreover, the cases vary so greatly in difficulty, and so much hangs on the result of the first examination, that it is well to study each, no matter how simple, with method and exactness.

Diagnosis.—*Importance of knowing the History of the Injury.*—When a person sustains a fracture, some provisional treatment is usually required and obtained from the by-standers (see Chap. xviii).

The surgeon should note carefully the history of the accident. He must ascertain when and how it happened, and should direct special attention to the position of the patient at the time of the injury. It is of importance to know if the limb was used or moved thereafter, and to what extent. People have been known to walk even a considerable distance with one of the bones of the leg broken. We wish to know the nature and amount of force which brought about the fracture, whether the violence was direct or indirect, so that we may be able to form an opinion as to the position and line of the fracture, and of the character of the displacement.

Examination of the Injury.—To follow out a complete

examination, have the limbs stripped and exposed. It is a good rule to remove the clothing from the sound limb first, after which the injured limb can be more readily freed. In like manner, when the patient is able to put on his coat or trousers, he should always *begin* with the injured extremity. It is best to cut away the clothing in bad cases. The companion-limb should be laid in a position similar to that of its injured fellow, and having ascertained whether there has been any former lesion or deformity, both may be compared. A glance may reveal the presence of abnormal elevations, depressions, or the filling up of hollows. Measurements should now be made. For this purpose certain fixed bony points should be selected on each side, and marked with ink. In the case of the leg, we would indicate the anterior-superior iliac spines and the tips of the external or internal malleoli. The surgeon then stretches an inch-tape or bandage from the one point to the other, so that it barely touches the skin; and looking vertically down on the ink-marks, reads off the length. For comparison and measurement both limbs should be laid in the same position. It must be remembered that normal limbs are subject to slight variations in length—the left leg being not infrequently longer than its fellow; and again, old inflammatory affections may have modified growth by causing increase or decrease in length. The surgeon should also gently pass his finger along the line of the fractured bone, noting any irregularities, as well as the locality and extent of the area where the patient has pain or tenderness.

It is now generally possible to say whether there be a fracture or not. One can form a fair estimate of the injury and of the dressings required. If there be no great amount of swelling, the sooner apparatus is applied the better. This should be of as simple a character as possible, consistent with efficiency.

Setting of the Fracture.—The setting of the fracture, and its retention in the proper position, depend on a knowledge of the chief displacing cause. This varies greatly. The *force* itself may have been the means of carrying the broken ends apart, and all that is needful, now that the violence has expended itself, is simple reposition. Again, *muscular action* may have wrought the evil, or may keep fractured surfaces asunder; in which case, relaxation by position of the muscles concerned, or gradual exhaustion of them by means of continuous extension will succeed. The weight of the limb, causing an outward rotation or separation of surfaces, is easily counteracted by giving support. The nature of the *line of fracture*, be it transverse or oblique, is also a matter of great moment, and must be taken into careful consideration in adopting a mode of treatment. Before setting the fracture, make sure that your splints are of the proper size. This is easily done by shaping them on the normal limb.

All being in readiness, the surgeon sees that the limb is firmly and steadily grasped *above* the seat of fracture by an assistant, while steady continuous extension is made *below*—the surgeon laying his fingers over the fracture, and manipulating there, if need be.

As the fractured surfaces are brought into apposition, the feeling of crepitus is often elicited. Where of parallel bones one only is broken, there is usually little displacement, and crepitus is not always to be obtained with ease. The plan of placing the fingers at each end of the bone, and making pressure while they approach each other, will aid largely in showing the seat of pain and obtaining characteristic crepitus. Thus in fracture, pressure *at a distance* will increase the pain at the injured spot, but in a bruise this does not occur. In difficult cases, for diagnosis and reduction, chloroform is invaluable.

If swelling should obscure the lesion, one is justified in deferring diagnosis, and meanwhile directing treatment to allay the swelling by means of rest, pressure, and evaporating lotions, as occasion may indicate. Such a detailed method of examination as we have given above is not, however, always necessary. In many cases, the well-known salient characters of the injury most frequent at the site in question are easily recognised. Should this not be the case, then the further methodical search indicated above is called for. In regard to treatment when confinement in the horizontal position is essential, the patient should always have a good firm bed, in which he cannot sink. For this purpose, nothing is better than a well stuffed, double-quilted, hair mattress. When such a bed cannot be obtained, and the ordinary mattress is soft and yielding, a wooden board may be placed beneath it.

Essentials of Treatment.—The great object in treatment is, firstly, to secure accurate apposition of the fragments, and secondly, to maintain a condition of rest and fixation until such time as repair is concluded. The limb should be comfortably and efficiently steadied, and all movement prevented. In order to ensure this, the principle of *fixing the joint* above and below the point of fracture is well worthy of consideration, since it is obvious that all muscles which pass over a joint, must influence it whenever they are called into action. Moreover, if the patient having any liberty attempts some little exertion, he is apt to fling the muscles into action; in endeavouring to keep the injured limb quiet, he renders the joints in the vicinity rigid, and, in fact, may entail movement at the seat of fracture.

Hence, in fractures of the leg and thigh, forearm and humerus, it is advisable—in the case of restless patients, at least—to fix the ankle, knee, and hip joints, or the wrist, elbow, and shoulder joints, as the case may require. The long splint and rectangular splint, with shoulder piece, fulfil this purpose admirably. In all cases of fracture it is of importance to ascertain whether there be any nervous lesion, and to watch for this during the subsequent progress of the case; since it sometimes happens that the newly formed callus may cause injurious pressure. For the first few days after treatment a daily inspection is required. Any pain or discomfort calls for examination, and the condition of the circulation must always be ascertained. A slight rise of temperature on the second or third day, even in simple fracture, is to be expected.

Prognosis.—The prognosis will depend largely on the nature and site of the break, and the habits, age, and circumstances of the patient. Fractures in the vicinity of joints, and in old and rheumatic people, are very apt to be followed by stiffness; while in young people an early ossification of the epiphyses may ensue, giving rise to stunted growth.

Material for Splints.—Gooch's splint, consisting of strips of lath glued to a backing of wash-leather canvas or strong paper, is supplied in rolls, and can readily be cut as desired. It is very serviceable in treating fractures of the long bones. Wire netting, perforated sheet zinc and tin, can also be fashioned without difficulty as required. Millboard and leather cut into shape and softened with water are extremely useful, and may be readily adapted; this is also the case with the more expensive poroplastic, which consists of felt, impregnated with resin. Strips of tin, shavings, cardboard, corrugated paper, hanks of lint, and bandages, may also be incorporated with plaster of Paris, and other stiffening agents, as will afterwards be described in discussing fixed forms of apparatus. Splints require careful padding, and this padding should be soft, elastic, and somewhat resilient, so that it does not cake. Raw wool, washed as it comes from the fleece, oakum, and lint, are rather better than cotton-wadding. Careful adjustment, so that hollows are filled up, bony points guarded, and equal support and pressure exercised, should be attained. If possible, a dependant position of the fractured limb is to be avoided, since it favours œdema; where the limb must hang more or less, a well applied bandage will largely obviate the difficulty.

Passive Motion to Obviate Stiffness.—Fractures which implicate joints are often associated with synovitis, stiffness, and adhesions. In order to obviate this, many surgeons hold that it is good practice to begin early passive motion. In the case of the elbow and wrist, they remove the retentive apparatus about the seventh or tenth day, and gently move the joint, while with one hand they steady and secure the fragments in position. The splints are re-applied perhaps with the joint at a different angle, and passive motion continued with increasing frequency.

Union is demonstrated when, after the lapse of time necessary for repair, there is no movement at the seat of fracture. The surgeon fixes one extremity of the broken bone, and gives the other lateral, antero-posterior, and rotatory movements, and thus judges of bony continuity. In doubtful cases it is well to have these movements executed by an assistant, while the surgeon handles the fractured region.

Non-union.—Besides imperfect coaptation of the fragments, continuous unrest and disturbance of the fracture—as, for example, when a patient sits up in bed with a fractured femur, or uses his fingers and wrist with a broken humerus—are very apt to cause non-union. Besides these we must also bear in mind that various constitutional conditions (such as syphilis, scurvy, &c.) may also play a part. More stringent measures to secure absolute fixation are in such cases ren-

dered necessary. All splints should be removed, the limb should be washed, and a little rough manipulation during the process will prove beneficial, by causing a fresh effusion of formative lymph. A more efficient apparatus must now be applied. Should fibrous union and false joint eventually form, nothing short of breaking down or removal of the uniting medium in some way can do good, since no amount of mere rest will induce ossification of fully formed fibrous tissue.

"*Greenstick Fracture*" is the term applied to the bending which bones in children are prone to undergo in place of fracture. Treatment is that of fracture. During the forcible replacement the bone may yield. The collar-bone and forearm are most commonly affected.

Dislocation *versus* Fracture.—It is convenient to consider dislocation along with fracture. The general characters of *dislocation* are fixation and distortion of the joint involved, due to a change in the relative position of the bones which form the articulation. *Fractures*, on the other hand, display abnormal mobility and distortion as regards the relation of certain parts of the bone to each other at the seat of injury. It is only when fractures occur in the vicinity of joints, more especially if of the nature of diastasis (epiphyseal detachment with no true crepitus), that there is difficulty in coming to a definite conclusion. By manipulation and support, we may restore the outline of a broken bone. Deformity again occurs when we remove the support. On the other hand, a dislocation is difficult to replace; but, when once reduced, tends to maintain its position. Naturally, there are numerous exceptions to such generalisations, as when, for example, dislocation occurs at some shallow ligamentous joint presided over by powerful muscles, in which case, although reduction be easy, retention is even more difficult than in fracture.

The sooner a dislocation is reduced, the better. This can in many instances be effected by rapid manipulation if one takes the patient unawares. Failing this, the administration of an anæsthetic will remove all difficulty. The limb is then to be kept at rest, and after a suitable period of quiet, passive motion is carried out.

B. Special Fractures—Upper Extremity.

(1) Fracture of the Clavicle is an exceedingly common injury. The typical displacement of the shoulder downwards, inwards, and forwards, occurs when the break lies at any point internal to the coraco-clavicular ligament. There is generally some irregularity at the seat of fracture, unless it lie between the conoid and trapezoid ligaments, in which case localised tenderness on pressure, taken in conjunction with the history of the case and the condition of the limb, affords ground for a positive diagnosis.

If the fracture lie external to the coraco-clavicular ligament, there is little tendency to downward displacement; but forward rotation becomes gradually well marked, should suitable treatment not be adopted.

Treatment.—Restore and retain the outer fragment. If the patient be confined to bed with a pillow between his shoulders, the weight of the limb no longer causes downward displacement, and the forward and inward distortion is remedied by the gravitation of the shoulders backwards, counterbalancing and exhausting the muscular action. Although satisfactory results may be obtained in this way, few people care to submit to such restriction and confinement, so that generally the patient is not treated in bed. Authorities differ as to the measures to be adopted for obtaining satisfactory union. The necessary indications are fulfilled by the following plans, which may be used and modified as circumstances indicate.

Fracture of the left clavicle at the junction of its inner and middle thirds.

(*a.*) *First Method—by Pad and Triangular Handkerchiefs.*

Materials.—Two triangular handkerchiefs; oblong pad of wadding; Domet roller; safety-pins.

Treatment.—Pad a sling with wadding in such a way that one end of the sling is longer than the other; thus the knot, when tied, will

Fig. 82.—Padded Handkerchief placed in the Axilla—For Fracture of Collar Bone.

Fig. 83.—For Fracture of Clavicle, Complete.

lie in front of or behind the sound armpit, as in Fig. 82. The second sling is arranged as in Fig. 72, so that its base lies beyond the elbow. The surgeon should now flex the forearm, carry the hand to the opposite shoulder, and brace back the shoulders, so as to restore the outline of the broken bone. He now raises the dependant angle of the sling, and ties it round the

neck (Fig. 82); in doing so, he can bring the elbow as far across the chest as is needful to maintain correct apposition. The apex

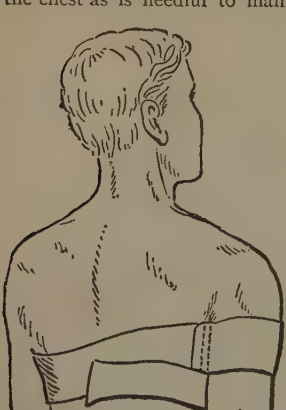


Fig. 84.—Sayre's Treatment for Fractured Clavicle—Application of the First Strip of Plaster.

Fig. 85.—Sayre's Treatment for Fracture of Clavicle, Front View.

of the sling is now carried behind the arm, and the three folds there secured by a pin. Finally the circular bandage (Fig. 83) binds the elbow to the side, and all is fixed by pins. The axillary pad acts as a fulcrum, and thus the shoulder is carried outwards, supported, and steadied; while the sling serves to remedy the downward and forward displacement. The pad is, however, seldom necessary, and as it may be overdone, is liable to cause œdema from pressure.

(*b.*) *Sayre's Method—by Plaster Strips.*—This plan, in which the chief factor is support exercised on the elbow, has certain advantages.

Materials.—Two strips of strong adhesive plaster, 2½ inches broad; boracic lint, or antiseptic wool.

Treatment.—Set the fracture. Fix a loop of the plaster (adhesive side out) around the middle third of the humerus by stitching, and carry it backwards around the trunk (Fig. 84). This serves to pull the shoulder backwards, and is said to give a fixed point for the second strip. Interpose lint or wadding between the chest and limb, wherever they are in contact. Lay the second strip of plaster against the sound shoulder, and carry it obliquely across the back to the elbow, where a slit should be made to receive the olecranon, and then ascend over the forearm to the starting-point,

so as to support and draw forward the elbow (Fig. 85). The injured shoulder is thus left free and exposed. It may be inspected at any

Fig. 86.—John Duncan's Method for Fractured Clavicle—Initial Turns of the Bandage.

Fig. 87.—John Duncan's Method for Fractured Clavicle—Completion by Acting on the Elbow.

moment without disturbing the dressing. There is no pressure exercised at the seat of fracture, a most important matter when the skin is at all injured, or a simple fracture threatens to become compound. Another method similar to that of Sayre, in which a bandage is employed, is seen in Figs. 86 and 87.

(*c.*) *Use of Padded Axillary Handkerchiefs.*—In fractures beyond the coraco-clavicular ligament and in others which are not attended with marked forward displacement, or where the patient is rather intractable, the shoulder may be braced back by means of two padded

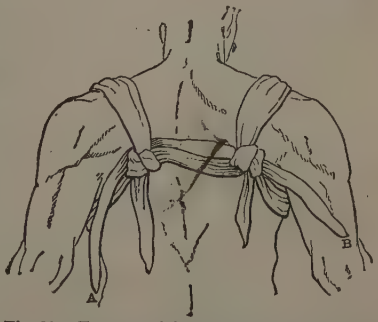


Fig. 88.—Fracture of the Clavicle—Treatment by bracing back the shoulders with knotted handkerchiefs. The ends, A and B, to be tightened and tied in the middle line behind.

axillary handkerchiefs (Fig. 88). The presence of knots behind may be obviated by interlacing the ends and tying in front (Fig. 89). Should the handkerchiefs threaten to mount over the neck and so relax, they may be secured to a pelvic band by intermediate slips. This is a better plan than using a series of figure-of-eight turns. At the end of three weeks the arm may obtain a little freedom.

Fig. 89.—Method of bracing back the Shoulders with Interlaced Handkerchiefs.

(2) **Fractures of the Body of the Scapula** are caused by extreme violence, and hence are commonly associated with other injuries of an even more serious character, such as fractures of the ribs.

Diagnosis.—The mobility of fragments, crepitus, and pain serve for diagnosis.

Treatment consists in retention by means of figure-of-eight turns with a Domet roller. The rarer fractures which are met with at the neck are only diagnosed by excluding the possibility of other injuries. Where the line of the fracture passes at the omo-hyoid notch, marked tenderness, with perhaps crepitus and abnormal mobility, is felt on manipulating the coracoid process. Where the glenoid alone is detached, a dislocation is simulated; but the contour of the shoulder is restored by merely supporting the elbow, and lost again on withdrawal of support—conditions which we do not obtain in dislocation. *Treatment* is similar to that of fracture of the clavicle; a light axillary pad, sling to support the elbow, and retention-bandage.

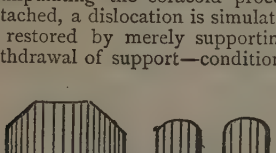


Fig. 90.—Gooch-Splints shaped for Fracture of the Humerus—Nos. 1 and 2 are cut to avoid pressure on the internal condyle, 3 is used to command the rest of the arm as in Fig. 91.

(3) **Fractures of the Humerus** may involve the extremities or the shaft. Shortening is one of the main features when the shaft gives way. Displacement is due to the direction of the force, character of the fractured surfaces, and the relation of the break to the deltoid and muscles attached to the region of the bicipital groove. The musculo-spiral nerve may be injured, or

involved at a later date in a mass of callus, thus giving rise to wrist-drop from extensor paralysis.

Treatment — General. — Reduce by means of extension and local manipulation. Well-padded Gooch-splints should be applied, cut so as to avoid pressure on the prominent internal condyle (Fig. 90). Secure with slip knots. Bandage the forearm to prevent œdema, and let it be carried in a sling, with the elbow free, so that the full effect of extension may be obtained from the weight of the lower fragment (Fig. 91). Many surgeons advocate with reason the application of a rectangular splint, which commands the elbow, wrist, and fingers, thus ensuring complete rest and fixation. Should this not be employed, the patient must be cautioned against using the fingers or hand in any way.

Fig. 91.—Treatment of Fracture of the Humerus.

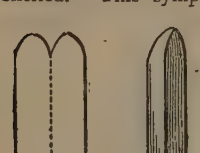
(*a.*) *Fractures at the upper end of the Humerus* are rather more difficult to diagnose than those which occur at a lower level.

Fracture at the Surgical Neck is common. It is generally rather oblique. The lower fragment is pulled upwards and inwards to the axilla, while the upper remains unaltered. Deformity and crepitus are marked features.

Separation of the upper Epiphysis from the shaft, a diastasis above the level of the surgical neck, is seen in young people up to twenty years of age. Here also the upper fragment remains *in situ;* the diaphysis is carried upwards and inwards, and its smooth rounded extremity lying in relation to the coracoid process gives rise to an appearance which exactly simulates sub-coracoid dislocation. Dislocation of the shoulder is, however, not frequent in youth; the glenoid is felt to be occupied, there is no true crepitus; the outline of the shoulder is restored on manipulation only to become again abnormal on removal of support, and so the nature of the lesion is rendered evident. The results of such epiphyseal injuries must be kept in mind, as regards their effect on the growth of the limb and relation to the joint in causing future stiffness.

In adults and old people, complete separation at the level of the anatomical neck sometimes takes place. It is generally associated with severe falls on the hand or shoulder, and is characterised by swelling and tenderness or pressure above the tuberosities. The length of the limb undergoes no appreciable change. By fixing the

upper fragment and rotating the lower, deep-seated crepitus may be elicited. This symptom is of course absent if the fracture be impacted, and it is better to arrive at a conclusion by eliminating other injuries, and avoiding such rough means of establishing a diagnosis.



a *b*

Fig. 92. — Shoulder-cap Shaped from Cardboard, *a*, and Moulded, *b*.

Somewhat allied injuries—such as splitting of the head of the humerus, detachment of the great tuberosity, &c.—are recognised by noting any broadening of the head and by a careful comparison of both shoulders.

Treatment.—All the above injuries may be treated on one plan. Set the fracture; pad the axilla; apply an external rectangular splint with a shoulder-cap, and bandage carefully from below upwards as far as the elbow. Finally, secure the arm to the side with a second roller, which may also support the forearm, or use a sling for this purpose. Some authorities dispense with a sling, and (more especially in the case of fractures above the level of the surgical neck) are content to fix the parts by means of the bandage (Fig. 61). Others, again, lay stress on the use or non-use of the sling in fracture at the surgical neck. Where the fracture is very oblique, it is better not to support the elbow, but to let it hang, as in Fig. 91. In any case an external shoulder-cap and axillary-pad may be used (Figs. 92 and 93).

It sometimes though rarely happens that in fracture of the surgical neck the upper fragment is tilted outwards, and cannot be replaced. Under such circumstances the lower fragment should be brought in line with the upper till union is obtained. Middeldorf's splint secures this end conveniently.

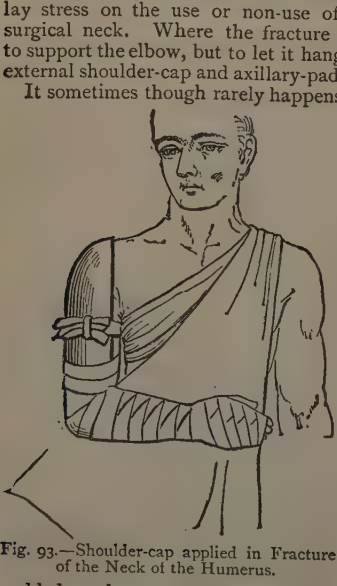


Fig. 93.—Shoulder-cap applied in Fracture of the Neck of the Humerus.

Stromeyer's triangular pad makes a comfortable and steady splint (Fig. 94) for fractures of the humerus. The parts are carefully adjusted on the cushion, and secured to it by straps.

(*b.*) *Fractures of the Shaft* are recognised with ease. Shortening is generally pronounced, the fracture being commonly oblique, with the fragments carried past each other. Gooch's splints, padded and cut away so as to avoid pressure on the bend

of the elbow or internal condyle (Fig. 90), should be applied with slip-knots. The arm, bandaged from the finger-tips to the bend of the elbow, is carried in a sling, leaving the elbow dependant, and a circular roller steadies all (Fig. 91).

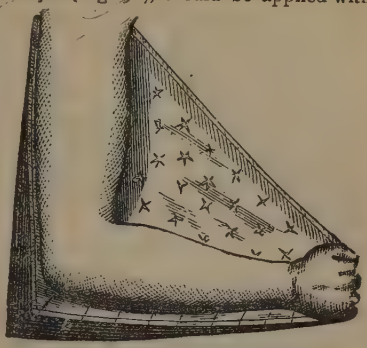


Fig. 94.—Stromeyer's Cushion.

In the case of untrustworthy patients, it is safer to use a rectangular splint in addition, so that the joints above and below the fracture may be commanded. This splint should also include the hand, since movement of the fingers has been known to cause non-union (Fig. 91).

Fractures of the humerus immediately above the condyles, or which implicate the joint, must be carefully diagnosed from dislocations. Should great swelling obscure the bony relations and render this difficult, one may either at once give an anæsthetic, and

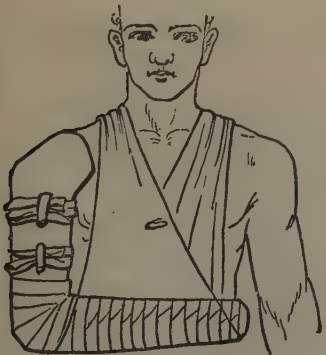


Fig. 95.—Rectangular Splint with Shoulder Piece.

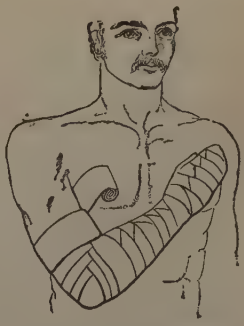


Fig. 96.—Fracture implicating the Elbow-joint treated in the flexed position.

make sure of the nature of the injury, or wait for a couple of days till, by the use of evaporating lotions and rest, the swelling disappears.

In treatment, it is well to place both limbs in the extended supine

position. The normal limb is then the model. Fragments are now to be replaced, and a pad of wool laid in the bend of the elbow. The limb is then to be flexed, and bent at an acute angle, and secured with figure-of-eight turns and a sling as in Fig. 96.

At the end of a week, gentle passive motion is begun in those cases where the joint is implicated, the surgeon retaining the fragments while he moves the forearm. This is done every third day, the limb being rebound at a different angle of flexion. After the sixteenth day, daily motion should be employed. Any subsequent stiffness of the joint will disappear through time under the effects of massage and suitable exercise, such as weight-carrying, rowing, &c.

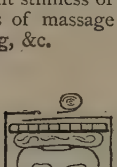


Fig. 97.—Diagram of Section of Forearm, showing preservation of interosseous space by means of suitable pads and board splints.

Fig. 98.—Gooch-splint cut away to avoid pressure on the ball of the thumb. (*N.B.*—The wood instead of the leather should be outside).

Many surgeons prefer to treat the fractures implicating the elbow joint with rectangular and boat-shaped or gutter splints and do not adopt early passive motion.

(4) **Fractures of the Bones of the Forearm** should be reduced by extension made from the hand, while some one fixes the arm above the elbow. Here also the supine position may be adopted with advantage during reduction. Anterior and posterior Gooch-splints should be cut and shaped on the normal arm. They should be broader than the limb. The posterior reaches from the elbow to the finger-tips; the anterior from the bend of the elbow to the palmar flexure, with a space cut out for the ball of the thumb. They should be well padded on their convex, *i.e.*, wooden surface, so that they will not mould to the limb and narrow the interosseous space (Fig. 97). The surgeon now lays them in position, the wooden face inwards, flexes the forearm to a right angle, and lays it midway between pronation and supination. He secures the splints with a couple of slip-knots, makes sure that there is no injurious pressure exercised at the bend of the elbow or ball of the thumb (Fig. 98), and bandages from below upwards. Due care is taken that the circulation is in no way impeded. Many surgeons prefer to fix the limb by means of a rectangular splint.

Such treatment is suitable for all fractures of the bones of the forearm, with the exception of that of the olecranon and of those immediately above the wrist and below the bicipital insertion in the

radius. In the last case, the supine extended position with an anterior splint, as in fracture of the olecranon, is recommended by some, while others prefer the flexed position.

(5) Fracture of the Olecranon, when transverse in character, with separation of the fragments, is readily distinguished. When the fracture is comminuted, more care is required in diagnosis. Marked tenderness on pressure, with broadening of the bone, is always suspicious, and when complicated with an injury to the bones, or with bruising of the skin, demands circumspect treatment, lest the

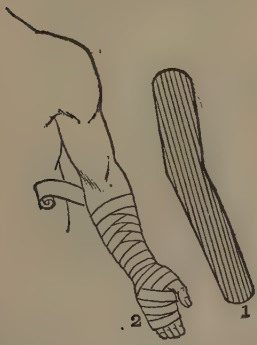


Fig. 99.—Bandaging the Forearm in Fracture of the Olecranon, 2, prior to the application of the anterior splint, 1.

Fig. 100.—Fracture of the Olecranon treated with elastic extension.

fracture become compound. Where there is much displacement, the following method may be adopted:—Cut an oblong piece of plaster with horseshoe-shaped extremities, to which stitch two extension tapes. Fashion from Gooch material a splint to fit the anterior aspect of the limb, so that the angle of the upper and forearm may be well marked (Fig. 99, 1). Bandage the forearm (Fig. 99, 2); lay the limb supine, and apply the plaster to the posterior aspect of the humerus, so that the upper fragment of the olecranon lies in the horseshoe, and carry the bandage up the arm, avoiding all pressure over the seat of fracture. Place the splint well padded, especially at the elbow, on the front of the limb, and bandage from below upwards, taking care not to include the extension tapes. Finally, an elastic band may be secured to the tapes and fastened to the end of the splint (Fig. 100). In this way, gentle traction is maintained, the fragments are brought into apposition, and good serviceable union secured. When the displacement is not marked, there is no necessity for the plaster and rubber extension; but a figure-of-eight bandage at the elbow will suffice. The patient is advised to have his hand as seldom as possible *dependant;* and

therefore, when at rest, he lays it on a table, and keeps it at a suitable level, so as to avoid œdema as far as possible.

(6) **Colles' Fracture of the Radius** above the wrist is extremely common. A prominent feature, most useful in diagnosis, is afforded

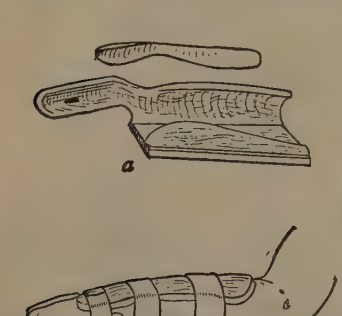


Fig. 101.—(*a*) Gordon's Splints for Colles' Fracture. (*b*) When applied the short prominent ridge supports the upper radial fragment.

Fig. 102.—Setting a Colles' Fracture.

by the examination and comparison of the styloid processes of the bones of the forearm on each side. When this fracture has taken place, the styloids are on the same level, whereas, in the normal limb, that of the radius is always much more prolonged downwards. In the absence of this symptom and of all typical displacement, it is advisable to treat as Colles' fracture the cases where marked tenderness on pressure exists, distinctly localised, just above the wrist, and associated with a history of a fall on the palm.

Treatment.—The great essential of treatment is careful and accurate setting. Following this, early passive motion is equally necessary. Special splints present no advantages. Reduction should be carried out at once, and with thoroughness, giving an anæsthetic, if needful. By using powerful extension and counter-extension, and flexing the wrist over the knee in cases of great difficulty, the fragment is restored to its normal position. It shows no great tendency to become again displaced. Padded Gooch splints are then applied. The dorsal reaches to the knuckles, the anterior to the palmar flexure (see Fig. 98). The bandage may include the fingers for the first week. After this date, daily passive motion of the fingers should be carried out, and every third day the splints may be removed, the fracture fixed, and the wrist gently moved. At the end of three weeks, remove all the splints.

(7) **Fractures of the Metacarpals** are associated with displacement due to a drooping of the head of the bone. By placing a small pad of wool in the palm of the hand, to prevent the finger-nails from irritating, and bandaging the closed fist over this, fixation is ensured, and union results in three weeks. When the first or fifth metacarpal has given way, it is, perhaps, better to secure the extended hand and fore-arm to an anterior padded Gooch-splint. This method may also be used in all cases.

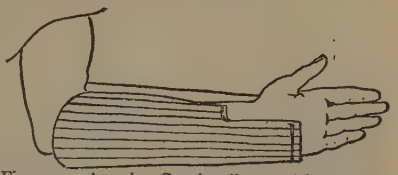


Fig. 103.—Anterior Gooch-splint used by some in Colles' Fracture. It is cut away in front of the lower fragment of the radius, and only reaches the middle of the palm.

Fractures of the Phalanges are treated by binding the injured finger and its fellows, in the extended position, to a splint, which is prolonged up the forearm.

CHAPTER XV.

ON FRACTURES—*Continued.*

Contents—C. Special Fractures of the Lower Extremity—General Treatment—Prevention of Bed-Sores—Application of Extension—Treatment of Fracture (1) of the Femur—in Children—(2) of the Shaft of the Femur—(3) of the Patella—(4) of both Bones of the Leg—Various Forms of Splint: Lateral, Dupuytren's, Macintyre's, &c.—General Remarks.

C. Special Fractures—Lower Extremity

General Treatment.—A patient suffering from fracture of the lower limb requires treatment in bed. Prolonged recumbency can only be carried out on a suitable mattress such as has been already described (p. 120); it should be firm, even, and unyielding.

Prevention of Bed-Sores.—The formation of bed-sores must be carefully prevented. They occur wherever pressure is kept up over bony prominences, such as the sacrum, heel, region of the buttocks, and popliteal space. Moisture is their chief causation—be it due to urine, sweat, discharge, or lotions. In old and weakly patients, extreme watchfulness can alone combat bed-sores. The patient must be kept absolutely dry. The skin exposed to pressure may be

strengthened by daily sponging with some hardening antiseptic lotion, such as spirits of wine and corrosive sublimate 1·2000, after which it must be carefully dried. In women it is advisable in many cases to draw off the water with a carefully purified catheter three times a day, and in both sexes the perinæum may be dusted with finely-powdered boric acid. Some difficulty is usually experienced at first in the use of the bed-pan. Where the patient is strong enough, he may assist by flexing the sound limb, and raising his pelvis with the aid of his arms and leg, while the slipper is introduced from before. Mattresses are also to be had with a moveable pelvic segment, which on withdrawal permits of the introduction of the pan.

Application of Extension—General Rules.—Features common to the majority of fractures of the lower extremity are found in the obliquity of the fracture, generally from above downwards and forwards; the shortening, and the tendency of the lower fragment to roll outwards. There is also seen drawing up of the heel. The position of extension is suitable during treatment in most cases, more especially since we can by a glance recognise to what extent eversion of the limb has been remedied. The internal edge of the patella, the internal malleolus, and the ball of the great toe, should always be seen to lie in the same vertical plane when the limb is extended. The application of extension is treated of in detail in Chap. xx. In the case of fractures, the plasters should stop short at the seat of injury. The limb is then to be laid in position between sandbags, for three or four hours, so that the plaster may get a grip, or we at once proceed to apply the necessary splints. After the lapse of suitable time, and having affixed the splints, buckle the foot-piece to the extension-straps, secure the pulley to the foot of the bed, and put on the weights.

From six to eight pounds is about enough for an adult. If spasm ceases and the limb is comfortable, there is sufficient weight.

Next raise the foot of the bed on props, and the patient's body acts as the counter-extending force. The limb should be carefully measured every day; and whenever the limbs are of equal length, weight must be decreased. Take off weight also if there be pain in the joints below the fracture. It is essential that the plasters should grip the skin over the lower fragment, rather than act as if through the medium of a joint, as this involves strain of the capsular ligaments.

(1) **Fractures of the Femur**, like those of the humerus, may be considered according to the portion which they involve. Shortening is sometimes of little value as a diagnostic of fracture of the neck of the femur. This symptom is usually delayed, and may take a day or two to develop when the fracture is intracapsular. It is sometimes inappreciable, if the fracture be impacted. In the latter case, the history and presence of antero-posterior broadening, with flattening latterly, and tenderness of the trochanter major, enable one to come

to a conclusion. Impaction should not be released in old people. An altered position of the trochanters is readily ascertained by the method of Bryant, Morris, or shortly as follows:—

Lay the normal line in the same position as its fellow. See that the pelvis is straight. When there is any pelvic obliquity, the lines drawn from one anterior spine to the other, and from the umbilicus to the symphysis pubis, do not intersect at right angles. Indicate the anterior superior spine and tip of the trochanter major on each side with ink; then take a couple of strips of stout sheet-lead, as recommended by Chiene, and lay them across the body, joining the above points. If the trochanters occupy the same level on each side, the strips will be parallel. Should they have undergone any change, the direction will be at once obvious, and a conclusion may be drawn as to the nature of the injury.

Fig. 103*a*.

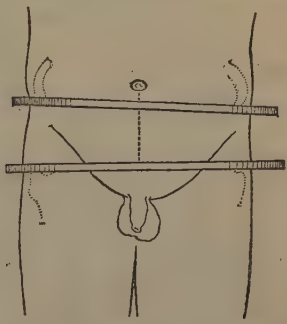


Fig. 104.—Method of ascertaining level of great trochanters and degree of pelvic obliquity.

Treatment and prognosis depend largely on the age and strength of the individual. In the case of old people, where the fracture is

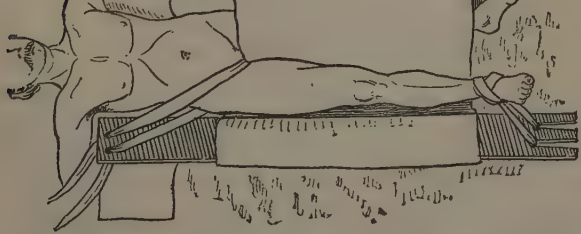


Fig. 105.—The Long Splint, showing the sheet, thoracic binder, and the perinæal band.

frequently intracapsular, prognosis should always be very guarded.

An attempt at treatment should be made. It fails where the strength or condition of the patient cannot stand the demands of the confinement required. The chest should be examined; and care as to the state of the circulation, and renal secretion, may save much initial trouble. The difficulty attending expectoration in bronchitis, the tendency to hypostatic congestion, and the embarrassment to breathing, swallowing, defæcation, and micturition, which attend the dependant position of the patient's body, have to be combated, till there be some degree of tolerance to the new state of affairs. The administration of digitalis, ammonia, and bark; the use of enemata, the catheter, and massage of the body will do much to improve the general condition.

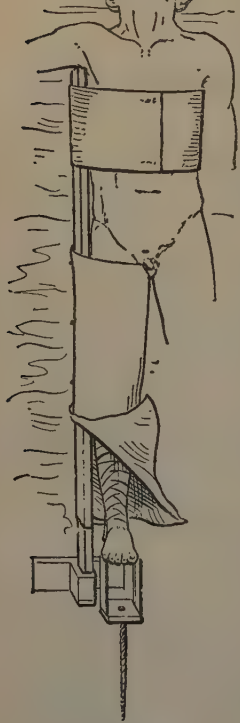


Fig. 106.—The Long Splint used with extension.

(*a.*) *First Method—The long Splint with Extension.*—In using the long splint with extension, the following articles are required:—

Materials. — Extension-plaster and tapes; three Domet bandages; a splint 4 inches broad, of suitable length, to extend from the axilla to beyond the foot, and a sheet; safety pins; a broad Domet roller for the chest; a foot-piece for the long splint; fine wadding; bed props; weights, cord, and pulley.

Apply the extension-plaster as described (Chap. xx.) Roll the splint in the sheet or tablecloth, leaving enough free to envelop the limb; lay it alongside the patient, and slip it under the leg as in Fig. 105. The loose end is then folded over; the weight for extension adjusted, and the bony prominences being suitably padded, the sheet may be secured to the splint with pins (Fig. 106). The thoracic binder is now passed under the patient (Fig. 105) and pinned. Finally, raise the foot of the bed as in Fig. 107.

(*b.*) *Second Method—The Long Splint with Perinæal Band.*—It sometimes happens, owing to the form of the bed or other circumstances, that extension with weight and pulley cannot be carried out. We may then employ the long splint with the perinæal band. With this a couple of large handkerchiefs folded *en cravatte* takes the

place of the extension apparatus. The splint and sheet are laid in position as formerly. The surgeon next secures one handkerchief to the foot (Fig. 105), and passes the other round the perinæum, so

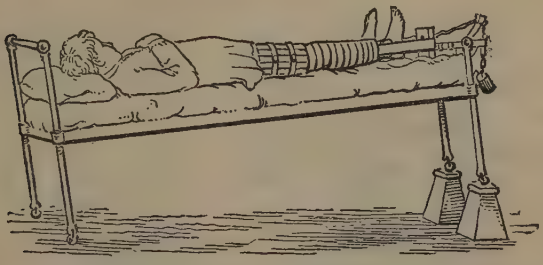


Fig. 107.—Extension by Weight and Pulley.

that the two ends may be through the holes in the top of the splint. He next secures the foot to the end of the splint, and now pushing it downwards, firmly with his hand, thus makes extension at the foot, while he maintains counter-extension from the perinæum by tying the top handkerchief (Fig. 108). Obviously before long

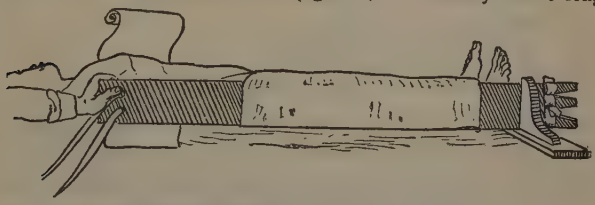


Fig. 108.—The Long Splint, showing how it must be pushed down in order to obtain extension before securing the perinæal band at the upper end.

the tension relaxes as the handkerchiefs give. The perinæum is apt to suffer and become excoriated: hence, although good results have been obtained with the long splint and perinæal band, the weight and pulley method is far superior. Where with the tilted position of the bed, the patient is uncomfortable, an attempt may be made, by means of a pelvic or thoracic girdle fixing the patient to the bed, to secure counter-extension. Union may be looked for at the end of ten or twelve weeks. Should the patient's constitution resent this treatment, he must be got out of bed into a chair, and only fibrous union be expected.

(2) **Fractures of the Shaft of the Femur** are also treated with the long splint and extension. They require as well lateral local splints of well-padded Gooch or pasteboard, secured with slip-knots. These splints must not encroach on the patella or

groin. In the case of fractures immediately below the trochanter minor or above the knee, some difficulty may be experienced in bringing the fragments into line; but this is overcome by the use of chloroform, and once reduction is affected and extension put on, retention is secured.

Fig. 109.—Double Long Splint.

(*c.*) *Fracture of the Femur in Children.*—It is noteworthy, as stated before, that in children fractures of the femur are more frequently met with than fractures of the leg-bones; they are usually more or less transverse. Children are not easily kept quiet or dry, and therefore treatment is complicated by two conditions, unrest and moisture. We meet these difficulties by using the double long splint, or vertical extension (Figs. 109 and 110). The double long splint is, moreover, well suited for restless adults and in cases of ununited fracture. It may be used with or without extension.

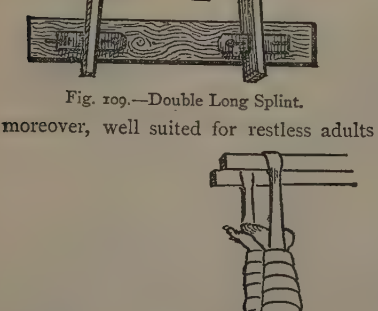


Fig. 110.—Vertical Extension for Fractured Femur in Children.

(3) *Fractures of the Patella* are in most respects comparable with fractures of the olecranon. In transverse fractures, there is marked separation of the fragments. The upper one is specially displaced by the action of the powerful quadriceps extensor, and in addition by the filling of the synovial pores of the joint with exudations and blood-clot. At a later date,

the ligamentum patellae also begin to contract and aid in the separation of the lower fragment.

(*a.*) *First Method—by Weight and Pulley.*

Materials.—A posterior splint with a foot-piece—a Macintyre—will suit; Domet bandages; a piece of diachylon-plaster, large enough to cover the anterior and lateral aspect of the thigh, and cut away in a horse-shoe form so as to fit the patellar region (to the horns of the shoe extension-tapes should be fixed); weight and pulley; wire cradle.

Treatment.—Bandage the foot and leg, apply the plaster, and carry the bandage up over it, excluding the knee and extension-tapes. Lay the limb extended on the posterior splint, and incorporate both with a bandage. Swing the limb on the cradle, raising the foot,

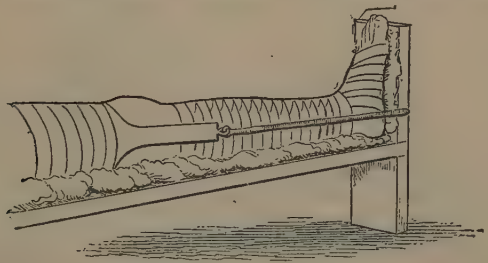


Fig. 111.—Fracture of Patella treated by elastic extension on the inclined plane.

and put on the weight and pulley. Should the joint be very tense, careful aspirations may prove beneficial. An ice-bag, or elastic pressure exercised through the medium of a mass of cotton-wool, will also aid in preventing effusion; but, as a rule, this is not required when the case is seen early.

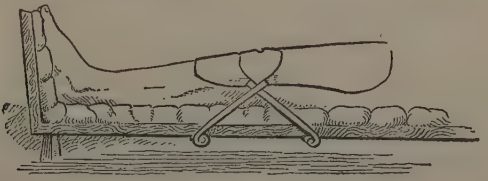


Fig. 112.—Fracture of the Patella, treated by the application of two pieces of plaster with elastic bands attached, so that both fragments of the bone are approximated and acted on. The bandage which secures the plaster has not been represented.

(*b.*) *Second Method—by Elastic Tubing.*—In place of using the weight and pulley, some surgeons attach the two extremities of a

loop of strong elastic tubing to the extension-tapes, and passing this over the foot-piece, keep up traction (Fig. 111). Others prefer the apparatus (Fig. 112), where both fragments are acted on by elastic force.

Malgaigne's Hooks give good result, when used with antiseptic precautions. The skin must first be carefully purified (p. 6), and the hooks disinfected. They are then forced into the upper and lower fragments, which are now approximated by a few turns of the screw. An antiseptic dressing is put on over all. At intervals of one or two days, the dressing is removed with antiseptic precautions, and the screw again tightened.

An attempt should always be made to secure osseous union. Moreover, since we usually only succeed in getting a short ligamentous uniting medium by the methods above described, and since this is extremely liable to stretch to an almost unlimited extent, if subjected to early strain, it follows that the longer the knee can be kept stiff in the position of extension, the better for the patient. Hence, the limb may be put up in starch at the end of eight or ten weeks. In sixteen weeks gradual attempts may be made to get a little flexion, but nine or twelve months should elapse before full flexion is allowed. It is questionable to what extent a surgeon is justified in cutting down upon and wiring the fragments in order to obtain osseous union. Stellate and longitudinal fractures are not so troublesome, and may be treated with a simple figure-of-eight bandage and posterior splint.

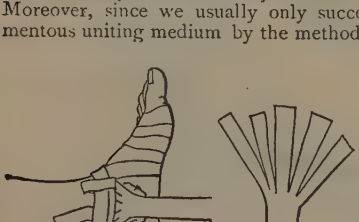


Fig. 113.—Fan-shaped Plaster for extension.

(4) **Fracture of both Bones of the Leg.**—When both bones of the leg are broken, there is usually marked displacement. This is not so when one alone gives way, as then the other acts as a splint. The customary displacement of shortening and rotation of the lower fragment outwards, may be met by careful setting and by extension with weight and pulley. When the break is very low down, so that it is somewhat difficult to get a grasp of the lower fragment, an attempt may be made by incorporating fan-shaped plasters (Fig. 113), with a bandage covering in the foot and ankle.

(*a.*) *First Method—In the Extended Position.*—For all fractures of the leg, there is no apparatus of such universal application as the **Box splint.**

Materials.—Two splints of light wood, ¼ inch thick, 4 inches broad, and long enough to extend from above the knee to a hand's-breadth below the sole. Three towels; both of similar length, and two somewhat smaller. Slip knots; bandage; wadding.

Treatment.—Roll the splints in the two ends of the largest towel, and, fitting them on the sound limb, leave sufficient space for it between the splints. Raise the broken leg, and set the fracture, slip the splints underneath the limb; raise the two sides of the box, and retain them in position with the hands. It is now an easy matter to insert pads where necessary, especially above the malleoli, under the tendo Achillis and near the knee. The two smaller towels are next folded so as to equal in length rather more than half the anterior aspect of the leg. They are then laid over the shin-bone, and all is secured by the three slip-knots (Figs. 114 and 115). The foot is bandaged, and the figure-of-eight turns

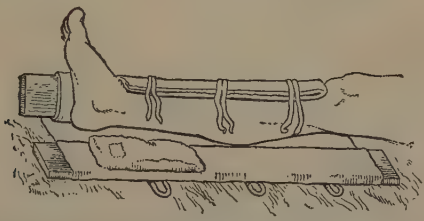


Fig. 114.—The Box-splint, showing arrangement of Anterior and Lateral Pads.

around the ankle ensure that the foot is at right angles. Finally, when necessary, the extension is adjusted. With the box-splint one can at once see whether the foot is at right angles or not, and to what extent rotation outwards exists. The tendency of the heel to pass backwards can be largely avoided by the use of a substantial ring-pad.

Second Method—In the Flexed Position.—Many surgeons believe that the position of flexion is one in which a broken leg may be treated

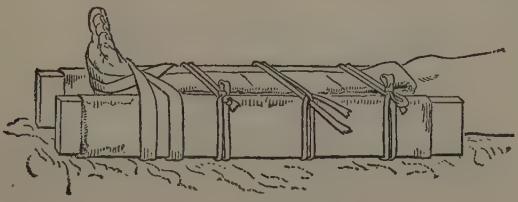


Fig. 115.—The Box-splint applied.

with most advantage. The principle of relaxing the muscles to prevent spasm is an old and good one, but the merits of extension are greater. One may, however, easily conceive cases and circumstances where the flexion method is preferable. By flexing the leg

and swinging it in a cradle, or laying it on its outer side, the hamstrings and gastrocnemic are relaxed, and the heel is kept at rest.

Various Forms of Splints.—In ordinary fractures, lateral splints of wood or pasteboard are used. They should be shaped to fit the limb (for pasteboard, see Chap. xx.) If of wood they may be cut short at the level of the instep; the *outer* should have a foot-piece; if made of pasteboard, both had better be provided also with a sole plate. Wooden splints should be perforated at the malleoli, to avoid pressure. The foot-piece of the external splint should be well padded towards the toes. After setting the fracture, the splints are buckled or bandaged on, and the limb, laid on its outer side, is secured by slip-knots to a pillow (Fig. 116). In this way pointing of the toes is readily prevented, but eversion of the foot cannot be so readily counteracted. If, however, two lateral splints of wood or pasteboard, each with a foot-piece, be fitted on, and the leg be now suspended from a **Salter's cradle** (Fig. 117), one can easily see if eversion is thoroughly corrected or not. In cases where backward displacement of the heel does not readily yield with the ordinary box-splint, the swinging position may also be taken advantage of.

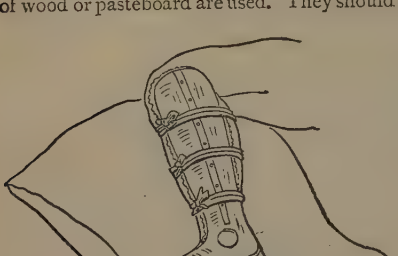


Fig. 116.—Application of Lateral Splints—Limb flexed and laid on its outer side.

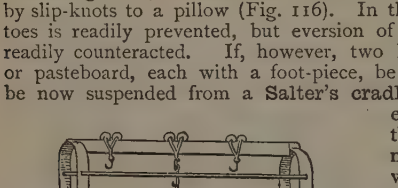


Fig. 117.—Limb slung in Salter's Cradle.

Splints for Pott's Fracture.—Special splints are sometimes used in the treatment of Pott's fracture and allied conditions, although as a rule such injuries are equally amenable to the box-splint.(*a.*) **Dupuytren's splint** is devised with the double object of counteracting eversion and of preventing the toes from pointing. It is a long splint in miniature (Fig. 118, A), and is applied with the aid of a bandage, slip-knot, and towel. Fold the towel, lay it against the inner aspect of the splint, and fold up the

surplus (as in Fig. 118, A) to form a pad. Split the ends of the bandage and fasten them through the two holes at the end of the splint; bring it down over the towel, and secure all with slip-knots (Fig. 118, A). The splint is now mounted. Set the fracture. Lay the splint along the inner aspect of the leg. Secure it to the leg below the knee with a slip-knot, and then proceed to incorporate splint and limb by four or five figure-of-eight turns (Fig. 118, B). By so doing, the foot is also fixed at right angles. As the bandage now travels

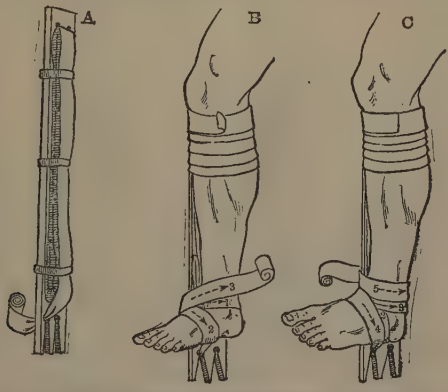


Fig. 118.—Dupuytren's Splint—A, Ready for use; B, Fixation to Limb; C, Method of producing Inversion of the Foot.

from over the outer aspect of the foot, it should be carried between the forks of the splint, and from that should pass over the front of the ankle round to the back, embracing the splint. Complete the new series of figure-of-eight turns, by once more reaching the front of the ankle, and descend over the fifth metatarsal to the forks. By this manœuvre, the foot is forcibly inverted, and the displacement caused by the accident remedied (Fig. 118, C). The splint should be firmly secured before the latter figure-of-eight turns are made, so that the heel is well fixed against the splint, which must on no account be allowed to slip towards the instep. In correcting eversion, the loops of bandage should act through the medium of the fifth metatarsal. Finally, the leg is laid on its outer side on a pillow.

(*b.*) In cases of Pott's fracture with marked tendency to backward displacement of the heel, an anterior *horse-shoe splint* has been used. It should be well padded to avoid pressure effects. Its application is illustrated by Fig. 119, where the tip of the heel is seen to rest in the handkerchief.

Macintyre Splint is extremely useful in all severe injuries of the foot, leg, and lower part of the thigh. It consists of a trough of sheet iron for the thigh, and one for the leg, both being hinged

together, and kept at any required angle by means of a screw. A foot-piece, which may not only be fixed at any angle to the leg-trough,

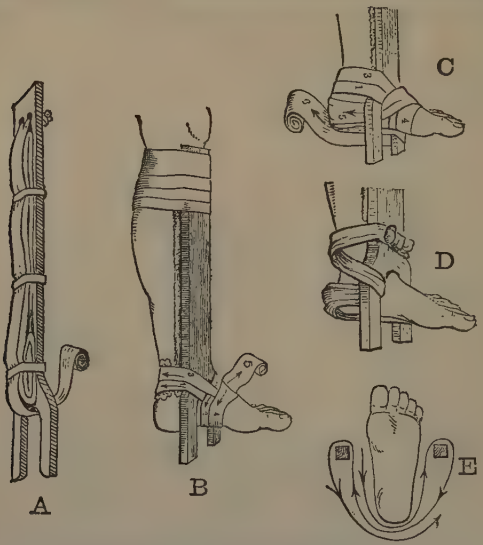


Fig. 119.—The Horse-shoe Splint—A, Ready for use; B, Fixation to Limb; C and D, Method of supporting the heel with a bandage; E, Supporting the heel with a handkerchief.

but which—working in slots—may be slid for a certain distance up and down it, is an important part of the whole. The foot-piece has a

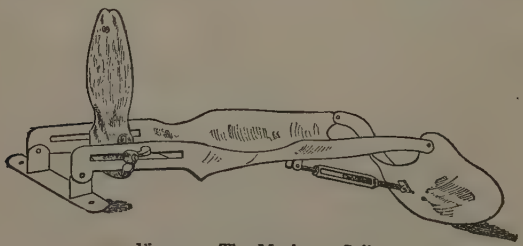


Fig. 120.—The Macintyre Splint.

concave ending, and is provided with a button for the purpose of giving attachment to a stocking or bandage, which draws forward the heel (Fig. 120).

Before the splint is applied, the distance of the foot-piece to the knee-bend must be accommodated to the length of the patient's leg, and the necessary angle of the thigh- and knee-parts determined upon.

Folded linen sheets, cotton wool, or other padding, must be laid on the trough, and the hollow between the lower end of the leg-trough, and the foot-piece filled up by transverse pieces of bandage.

When the leg has been laid upon the splint, the surgeon begins by fixing the foot with turns of bandage, ensuring comfort by plentiful padding on the dorsum, below the heel, and under the sole of the foot. Then, with a roller-bandage, he fixes the limb to the leg- and thigh-troughs. Some make the patient wear a sock, to the toe of which a tape is fastened; this being brought over the concave end of the foot-piece is fixed to the button before noticed.

General Remarks.—Fractures of the leg are usually united in from four to six weeks. Prior to this period they may be, however, put up in starch or plaster of Paris, and the patient may leave hospital on crutches.

Before the days of extension, fractures of the femur were frequently treated in the flexed position. Such forms of apparatus as Earl's bed were made use of when there was marked displacement, as occurs after fracture below the lesser trochanter, or above the condyles. By means of chloroform and extension, we now get over the muscular spasm, nor is it necessary to divide the tendo Achilles, as has been sometimes recommended to meet the last-mentioned instance. When patients have to travel a distance, and a temporary dressing is made use of, lashing the flexed limbs together to a pillow is often advantageous.

CHAPTER XVI.

ON FRACTURES—*Continued.*

Contents.—D. Fractures of the Spine, Ribs, and Pelvis.—(1) Spinal Injuries—Their Gravity—Immediate Treatment—Attendant Dangers—(2) Broken Ribs—(3) Fractures of the Pelvis—Possible Complications.

E. Fractures of the Head and Facial Bones.—(1) Scalp Wounds—(*a.*) Compound Depressed and Punctured Fractures—"Concussion" and "Compression"—(*b.*) Fractures of the Base of the Skull—(2) Fractures of the Facial Bones—(*a.*) of the Nasal Bones—(*b.*) of the Upper Jaw—(*c.*) of the Lower Jaw—Use of Antiseptics.

D. Fractures of the Spine, Ribs, and Pelvis.

(1) **Spinal injuries** are extremely grave, as the associated concussion, hæmorrhage, or sprain, may lead to most serious inflammatory changes in the cord.

Fractures are of common occurrence, and are usually recognised by local irregularity and tenderness of the spine, and the sudden development of motor symptoms. The higher up in the spinal column the fracture or dislocation lies—thus affecting the cord—the greater will be the resulting paralysis; and consequently respiration may be carried on by the diaphragm alone, all the other nerves save the phrenic being inactive.

Immediate Treatment.—In most cases a plaster jacket should be applied in the horizontal position (see Chap. xxii.). In extreme cases the patient should be laid at once on a water-bed, and the site of the lesion, together with the condition of the bladder and rectum, ascertained. Defective innervation of the parts supplied beyond the seat of the lesion predisposes to trophic changes, bed-sores, and inflammations. The greatest care must be exercised in drawing off the urine, which should be done at regular intervals with a disinfected catheter. The overflow of an over-distended bladder must not be taken for normal micturition.

Attendant Dangers.—The patient is specially liable to pulmonary troubles. Hypostatic congestion, bronchitis, and inflammation may prove speedily fatal, for he may have lost the power of coughing. At points of pressure bed-sores arise; hence the use of cages to protect the toes, and the necessity for shifting the position daily to some slight extent, and keeping the patient dry (p. 134). Careful investigation and records should be made at intervals of the extent and nature of the paralysis—sensory or motor, &c., the condition of the various reflexes, and the existence or development of hyperæsthetic areas or zones.

Prognosis.—The slightest return of motor power within the first six months, any improvement in the cystitis which is so generally met with, or a more healthy condition and healing of the bed-sores, are favourable prognostics.

(2) **Broken ribs** arise mostly from blows and squeezes, but may also be caused by violent muscular action on the part of the patient himself, as, for example, in coughing. The patient endeavours to keep the part at rest, and so abstains from taking a long breath, any attempt at which causes severe local pain. If the pleura be wounded, he would fain cough, but dare not do so. If the fragments have injured the lung, he may expectorate blood.

On manipulation, local tenderness is manifest, and crepitus may sometimes be made out; but too active endeavours to elicit this should not be made. The stethescope may help; as a rule, the methods referred to on p. 120 are most serviceable; and pain on pressing the rib at a distance from the injury indicates fracture.

Where fracture exists, a species of plaster cuirass may be formed out of overlapping strips running from spine to sternum of the whole affected side. In doubtful cases it is always well to give support, and a Domet-roller, disposed in a series of sloping figure-of-eight turns around the thorax, will do what is necessary.

For great dyspnœa after thoracic injuries, bleeding has been used with benefit.

(3) **Fractures of the Pelvis** are common, as the result of severe crushes. The patient frequently suffers from shock.

Possible Complications.—The injury is of moment from the liability to damage of the pelvic organs, and hence the question must be asked: Has the patient made water or not? If he has not, a duly purified, soft rubber catheter, or failing that, a gum elastic instrument should be passed and the water drawn off. If any difficulty be met with and blood appear in the urine, the propriety of tying in the catheter may be discussed. This should certainly be done, if on inserting the finger into the rectum any irregularity of the pubic arch denoting fracture be felt. When the urethra has been injured by fracture of the pelvis, the rupture is in the membranous urethra posterior to the triangular ligament, and if extravasation of urine occurs, it will be intra-pelvic, perhaps unrecognised, and liable to do more damage than the familiar extravasation into the perinæum and scrotum, associated with rupture anterior to the ligament. If one cannot pass an instrument, it is probably better, meanwhile, to aspirate the bladder, and at the earliest possible opportunity put the patient in the lithotomy position, incise longitudinally, and, if possible, suture the ruptured channel, leaving in a tube to drain the bladder, posterior to the site of injury.

Prognosis.—If the bladder and urethra have escaped, fracture of the pelvis does not generally give rise to much anxiety. Examination from the rectum and along the crests of the iliac bones will reveal the line of the lesion. Rest in bed and fixation by a roller-bandage and pillows serve as treatment.

E. Fractures of the Head and Facial Bones.

All head injuries require consideration and care. From lack of attention grave results may follow the simplest lesions, and from want of observation important data may be missed. Wherever the skin is broken, the most stringent antiseptic precautions should be enjoined. They are absolutely essential when the bone is in any way injured. Should sepsis occur, there is practically no limit to the ulterior consequences, and these may vary from a local redness to a general meningitis.

(*a.*) **Scalp wounds** are to be treated on general principles. Owing to the great vascularity, every shred of tissue that is not killed outright should be preserved. The hair should be shaved off, and everything most rigorously cleansed with antiseptics. By means of acupressure (p. 45) a more rapid arrest of bleeding may sometimes be obtained than by the use of ligatures.

(*b.*) **Compound Depressed** and **Punctured Fractures** always require trephining—probably all simple depressed fractures should be elevated or treated in the same way. An exception may be made with young children, where, unless the symptoms are rapidly progressive and life is threatened, it is legitimate to delay, as the young and elastic calvarium usually rises.

(*c.*) **Concussion and Compression.**—Whenever, as the result of a blow or fall, the patient has become unconscious, a guarded prognosis should be given. Even if the patient have rapidly regained his senses, he requires exceeding care. The unconscious condition produced suddenly by an injury to the head is known as **concussion.** The patient in this state lies faint and listless, with a weak irregular pulse, and he can be often partially aroused. The breathing is shallow and weak. The pupils react to light and vary as to size. Recovery takes place gradually, and commencing reaction is frequently associated with nausea and vomiting.

Treatment.—Keep the patient warm and quiet. He must always be carefully watched, and stimulants should be avoided. Concussion may, however, go on to **compression,** or there may be an interval between the two. The patient now becomes gradually insensible, and cannot be roused at all. He sinks into a stupor and lies breathing heavily, with loud, stertorous, slow respirations. His pulse is slow and dragging; the sphincters are paralysed; urine accumulates; the eyes no longer react to light; the pupils are frequently dilated; the condition deepens, and he dies comatose.

Such a state of affairs calls for immediate action. An attempt must be made to remove the compressing agent—be it bone, blood, or inflammatory product. In cases where after a simple injury, with, it may be, only slight concussion, symptoms of compression develop, any delay in treatment may be fatal. Such cases are often due to rupture of the meningeal artery, and are characterised by the rapid onset of compression, associated with dilated pupil on the side of the hæmorrhage, and muscular paralysis on the other. Only immediate trephining can then save life. The condition of the pulse may mislead. In some instances it is rapid instead of slow and dragging. In all cases absolute quiet, cold to the head, and counter-irritation (by means of croton oil purgation) is to be recommended, as well as bleeding behind the ears.

(*d.*) **Fractures of the Base of the Skull** are characterised by the escape of cerebro-spinal fluid from the ear, or by bleeding from the ears, mouth, and nose, conjunctival ecchymosis, and occasionally by facial paralysis. In addition to general treatment, an attempt should always be made to combat septic meningitis by gently syringing the ear with 1·20 carbolic, dusting in iodoform, and plugging with antiseptic wool.

(2) **Fractures of the Facial Bones** present the peculiarity that they are frequently compound from involvement of the mucous membrane of adjacent cavities. However, they are not more dangerous on that account, since here sepsis is not so obnoxious, because of the great vascularity and the free drainage that is afforded when the mucous surface as well as the skin is wounded. The amount of damage is often veiled by the great swelling, which generally comes on with much rapidity; hence the sooner the patient is seen and his injuries recognised and treated, the better. Diagnosis is favoured by the examination which can be made from the nasal and oral cavities, as well as by external manipulation.

(*a.*) **Fracture of the Nasal Bones** results from great violence. The fragments must be raised from within by a probe, and the septum restored if need be with dressing forceps, as nasal plugs do no good. The patient must be cautioned not to finger the parts, nor to blow his nose violently for a week. If retention is difficult, it is better to give an anæsthetic, and skewer the elevated broken bridge with a stout steel pin.

(*b.*) **Fracture of the Upper Jaw.**—When the upper jaw is broken, the alveolar margin is usually interfered with, and loose teeth require attention. None should be removed unless they are broken, or their alveoli hopelessly destroyed. Otherwise, they should be replaced, the bone modelled into shape, and the lower jaw bound to the upper by means of a split bandage (Fig. 121); the opposing teeth act as splints. The patient is enjoined absolute quiet, and fed with slops by means of a tube carried from the mouth behind the last molar, or through a dental gap, or from the nose.

As a general rule, injuries of the face implicating the malar bone and jaw are severe and complicated with laceration of the soft parts, but are generally hopeful. Every fragment should be retained and sutured, coagula removed, the parts purified, dusted with iodoform, and treated as special circumstances require.

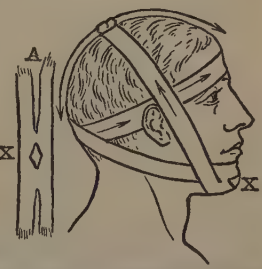


Fig. 121.—A, Four-tailed Bandage for Fracture of the Jaws; X, Aperture for the Chin.

(*c.*) **Fracture of the Lower Jaw.**—When a patient has sustained a violent blow on the lower jaw, and he is bleeding from the gums with loosening of teeth,

Fig. 122.—Chin-cap Moulded out of a Piece of Gutta-percha, ⅛-inch thick, softened in boiling water.

Fig. 123.—Chin-cap kept in Position by Handkerchiefs.

care should be taken not to overlook the possibility of fracture. It is well then to grasp and steady one half of the jaw firmly,

and to make forcible movement of the other half in various directions, as it sometimes happens that the fragments interlock, and there is no evident displacement. When fracture is diagnosed or well marked, and the fragments readily retained, a split handkerchief (as in Fig. 123) may be applied over a guttapercha or pasteboard chin-cap (Fig. 122). After-treatment is similar to that in fracture of the upper jaw. In more difficult cases, the use of interdental vulcanite splints, with aperture for feeding, can be adapted with the aid of the dentist. Immediate wiring of the fragments (not adjacent teeth) has been advocated, and carried out with much success.

Use of Antiseptics.—In all fractures of the facial bones where mucous cavities are involved, marked benefit attends the use of antiseptic washes. Warm water, having Condy's fluid or chlorate of potash added to it, may be used with a syphon, and frequent irrigation in this fashion gives the patient much comfort and prevents fœtor. A continuous purulent discharge denotes a local necrosis of bone, which requires removal as soon as it is loose.

CHAPTER XVII.

DISLOCATIONS, SPRAINS, AND BRUISES.

Contents.—Diagnosis and General Treatment—Special Treatment for **Dislocation** of the Clavicle—Shoulder—Lower Jaw—Elbow—Wrist-joint—Thumb—Hip-joint—Patella—Knee, Ankle, or Astragalus—Cautions necessary in old-standing Cases—Treatment of **Sprains** and Bruises.

Dislocations—Diagnosis.—It is obvious that the methods adopted to discover the existence of fracture are equally serviceable in the case of dislocation. As fractures are characterised by preternatural mobility at a part of a bone which is normally *rigid*, so dislocations show preternatural fixation of a *movable* joint, along with an abnormal relation of certain associated bony structures. Naturally, the exceptions to this generalisation are many; and—more especially when we deal with impacted fractures in the vicinity of joints—there is sometimes a degree of doubt, only to be cleared away by careful observation.

General Treatment.—The behaviour of dislocations after reduction varies much. Where the adjacent bone-surfaces embrace each other closely, or are held in apposition by strong muscles or ligaments which remain intact, the tendency to redisplacement is not well marked; whereas, if the opposing surfaces be small and shallow, and the uniting ligaments be greatly destroyed, the slightest motion will bring about the dislocation afresh. This is well seen if

we compare a dislocation of the shoulder or hip, with one of the clavicle or head of the radius. In reducing the dislocation, we may either by gradually increased and prolonged force weary out the resisting muscular structures, and so effect a cure; or, again, by means of manipulations which tend to relax the tense muscles, and by making use of the dislocated bone as a lever, we may cause the escaped articular end to retraverse the path it took in leaving its companion-bone, and so regain its normal position. Subsequent treatment consists in retaining the bones in position till the capsule heals, and using passive motion at an early date in order to obviate the formation of adhesions.

(1) **Dislocations of the Clavicle** occur at either end. They are usually replaced with ease, but retained with difficulty; they are amenable to treatment similar to that used in fracture of the collar-bone. Attempts should also be made by means of a pad to retain the displaced surface; for this purpose elastic bands, strapping, or a hernia truss have been recommended.

In dislocation at the acromial end, the arm should be supported in a sling at a right angle, and the separated surfaces kept in position by a few turns of elastic webbing, running round the shoulder and elbow. The elastic is kept from slipping by a thoracic belt. The usefulness of the limb is not greatly impaired even where a good result as regards appearance is not obtained.

(2) **Dislocation of the Shoulder** may be made out from several features. The patient generally supports his semiflexed arm midway between pronation and supination. The elbow is tilted from the side. The shoulder is flattened—not rounded, as on the normal side, and the level of the axillary border is lowered. If a measuring-tape be carried around the circumference of the axilla over the clavicle and acromion, it will be found that in dislocation there is an increase of from one to two inches, as compared with the opposite side. If the hand be lifted to the top of the opposite shoulder and held there, it will be found that no force can bring the elbow against the chest-wall. This test may fail in old-standing cases. The great proof of dislocation, however, is afforded by the change in the relative position of the coracoid process, the acromion, and the great tuberosity of the humerus. The first two must be identified; the last should be about an inch below, and outside the former two. If the articular cavity be empty, the elbow should be rotated, and the head of the bone will be found anterior, inferior, or posterior to its normal site.

The varied forms of dislocation here are recognised more by direct observation as to the position of the displaced head. There is not much to be gained by measurements as to the length of the limb.

Reduction—First Method—by Heel in Axilla.—Fix the shoulder-girdle and use extension, with the heel in the axilla. Lay the patient on his back on a mattress or couch (Fig. 124). Take a few turns with a wetted bandage just above the elbow; over this slip a clove-hitch on a lac of worsted, and fix it with a few more

turns of the bandage. The surgeon now removes his boot and places his heel in the axilla, fixing the border of the scapula with it, flexes the patient's arm, and makes steady traction, occasionally slackening

Fig. 124.—Reduction of Dislocation by Heel in the Axilla.

off. When reduction is effected, he should manipulate the joint to make sure of his success. Good results are also gained by extending

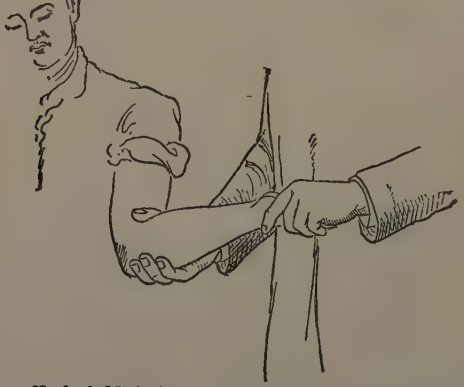


Fig. 125.—Kocher's Method—First Part, External Rotation of Humerus.

the limb, and carrying it directly upwards. A similar mode is that in which the surgeon stands behind the semi-recumbent patient,

fixes the shoulder-girdle with one foot, and raises the arm above the patient's head.

Second or "Manipulation" Method of Kocher.—The so-called "manipulation" method of Kocher is performed by flexing the forearm to a right angle, and then pulling the hand outwards so as to rotate the whole humerus. As this is done, the tip of the elbow may advance a little in front of the chest (Fig. 125). This movement must be carried out with great patience, and should occupy at least five minutes. The surgeon then rapidly rolls the humerus inwards, and circumducts it over the front of the chest (Fig. 126). As he brings it to the side, reduction takes place.

Fig. 126.—Kocher's Method—Second Part, Raising the Arm, Internal Rotation and Circumduction.

In every case where this is difficult, chloroform may be given.

Subsequent Treatment.—Rest the joint by means of supporting the elbow in a sling, and binding the limb to the side. Begin gentle passive motion at the end of ten days.

(3) **Dislocations of the Elbow** are most readily diagnosed by finding the condyles of the humerus, noting the relation of the head of the radius to the end of the olecranon condyles, carefully exploring the bend of the elbow, and noting to what extent movement is interfered with. In the common backward displacement of both bones, the cup-shaped head of the radius is readily detected posterior to the condyle, and the bend of the elbow is filled up with the projected extremity of the humerus. By extension and rapid flexion, reduction takes place; moreover, this is not attended with crepitus, nor yet with redisplacement when support is withdrawn, as is so well-marked in cases where the humerus is broken. After every reduction the surgeon must fully flex the limb, in order to satisfy himself that all is right. Treatment is then similar to that for fracture into the elbow-joint (see Fig. 96).

It sometimes happens that the radius alone is displaced, and its head is to be found lying in front of or behind the external condyle. In such a case, the surgeon extends the fore-arm, supinating in the first form, and pronating in the second, to get the parts in apposition. It is difficult to retain; hence, a special pad should be bound over

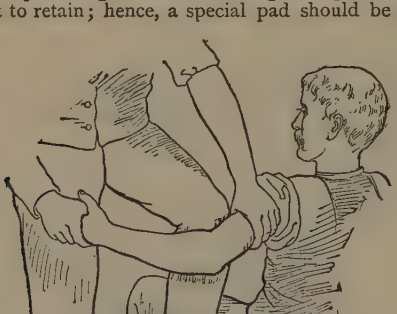


Fig. 127.—Reduction of Backward Dislocation of Elbow over the Knee.

its head, and the elbow kept at rest for a longer period than in other dislocations.

(4) **Dislocation at the Wrist-joint** is easily recognised, and as easily reduced. When the phalanges are displaced, there is some little difficulty in getting a grip of the small distal extremity. The toy known as the "Siamese link" gives one a good purchase, or somewhat similar methods may be improvised.

(5) **Dislocation of the Thumb** is often very stubborn. By forcing the metacarpal well into the centre of the hand, fitting on the Siamese link, making extension in the direction of displacement, and then suddenly and forcibly flexing in the opposite direction, the ligaments and tendons may be so stretched that the reduction takes place.

(6) **Dislocation of the Lower Jaw.**—The recognition of this is simple in the extreme. The patient cannot close his mouth or articulate; the glenoid articulation is found to be empty; but the condyle may be felt at the eminentia articularis; the masseter and temporal muscles are tense. The condition may occur on one or both sides. For reduction, the patient sits on a low stool facing the surgeon, who lays his thumb on the last molars of the dislocated jaw, and places his fingers firmly beneath the patient's chin. He then forcibly pushes downwards and backwards with his thumbs, upwards and forwards with his fingers; and as he feels the jaw move, dexterously withdraws his thumbs as reduction is effected.

The thumbs may be protected with a napkin. Subsequent retention and treatment are as in simple fracture of the lower jaw.

(7) Dislocation of the Hip-joint presents the marked feature of an inverted limb, when the head of the femur has passed backwards or upwards. If it lies forwards and downwards in the obturator foramen, the toes are pointed and the limb abducted and everted. In every case, the leg is so fixed, that attempts to straighten and flex up the knee or hip-joint are always associated with more or less of a rocking motion of the pelvis, which takes place through the lumbar vertebræ—as may be established if one lays his hand under the back, while he puts his patient through these movements. In direct displacement forwards, the head of the bone is readily felt out of place.

The posterior displacements are the more common. Reduction is most readily effected under chloroform. The patient is laid on his back, and as soon as he is deeply "under," the surgeon flexes the leg on the thigh, the thigh on the abdomen. Thus he relaxes the ilio-psoas and ilio-femoral band (Y-shaped ligament), and,

Fig. 128.—Reduction of Dislocation of Hip.

moreover, causes the head to descend and lie rather in relation with the rent in the capsule through which it emerged. He then, grasping the patient's ankle, circumducts the limb outwards and extends, and the head enters its socket.

If the dislocation be of the *obturator or pubic form*, the first part of the procedure is similar, but the surgeon circumducts to the inside. As Prof. Chiene briefly puts it:—Where the head lies to the *outside* of a vertical line drawn through the acetabulum, circumduct *outwards* after flexion; if it lies to the *inside*, circumduct *inwards*.

It may happen that the head travels backwards and forwards between the obturator foramen and the region of the sciatic notch, in place of entering the acetabulum, while one attempts reduction. If the surgeon will, however, execute the movements, while he lifts the patient by the leg, as it were, it will be found that the head usually clears the rim of the cotyloid cavity, and becomes replaced.

After-treatment consists in tying the patient's legs together in bed, and putting on a pelvic band. If necessary a long splint may be used.

(8) **Dislocations of the Patella** are not unfrequently reduced by the patient himself. They are easily recognised, and yield to flexion-movements, combined with rotation and extension.

(9) **Dislocations of the Knee, Ankle,** or **Astragalas** are commonly compound.

Cautions to be observed in old-standing Cases:—Reduction of old-standing dislocations should not be lightly undertaken, and the whole circumstances of the case must be carefully reviewed.

Treatment of Sprains.—If seen immediately after the accident, the injured part should be held for a few minutes under a cold tap; the limb should then be raised, wrapped in cotton wool, and firmly bandaged, a splint being put on to keep the parts at rest. These measures aim at limiting the subcutaneous bleeding. The great pain which often follows a few hours after a bad sprain, especially when not treated at once, will be most relieved by hot fomentations, but as these increase the after-swelling, they should be limited, and as far as possible avoided. The pain which may appear eight or ten hours after the injury, and which may continue for a day or two, is due to inflammation, and is best treated by rest and elastic pressure, and by cold applications—such as an ice-bag, or a bandage or cloth wetted in cold water, or in an evaporating lotion, and exposed to the air.

As soon as acute symptoms have subsided, the swelling should be treated by firm elastic pressure and rest, with occasional gentle rubbing in the course of the nerves and lymphatic channels.

In most cases, simultaneously with the subsidence of swelling, gentle passive and active movements should begin. It may, however, be necessary for the joint to be supported for some weeks after the injury. The risk of chronic inflammation beginning should always be kept in view, especially in patients of a strumous constitution (see *Joint fixation*).

Where much thickening results after a sprain, the joint as well as the muscles which act over it should be steadily treated by massage (Chap. xix.)

Bruises must be treated much in the same way as sprains—by restraining subcutaneous hæmorrhage at first, giving rest to the injured tissues, and afterwards promoting absorption. The domestic remedy of a piece of raw meat bandaged over a bruised part is an example of a good means of ensuring cold and pressure. Hence its value.

CHAPTER XVIII.

EXTEMPORARY APPLIANCES AND CIVIL AMBULANCE-WORK.

Contents. — Extemporary Appliances in Civil Life — Accidents — **Fractures**—Extemporary Splints—How to lift and carry an Injured Person—Extemporary Stretchers and Slings—**Bleeding Wounds**—Domestic Antiseptics available—Bleeding from an Artery—Extemporary Tourniquet—Rules for Bearers of the Wounded—Formation of Ambulance Classes.

IN time of war, the necessities of the case demand that use should be made of whatever comes first to hand for the extemporary manufacture of splints and stretchers. As no amount of precautions and no organisation can ever entirely obviate the difficulties of attending to the Wounded in war, the utilisation of arms and accoutrements for making splints and stretchers, and the possible applications of a triangular handkerchief as a simple form of bandage and retentive apparatus, have been made the special study of military surgeons in civilised countries. In recent years it has been recognised that circumstances much resembling those of war very frequently occur in civil life—in so far, that accidents of all kinds happen when no trained assistance is at hand, or special apparatus is available. On this account, Civil Ambulance classes have been formed all over the country in order to train non-professional persons to give "first aid" to the injured with such apparatus as may be generally available. So much attention has been given to this subject by lay-people, that few medical men—far less medical students—could, without having specially studied it, put up an ordinary fracture on the street so neatly or so well with umbrellas, sticks, and handkerchiefs, or other extemporary apparatus, as a well-trained member of one of those classes. Considering that many of these men are skilled mechanics, and that they enter upon this practical work with the keenest interest, we need not be surprised that their standard of excellence is very high. It, therefore, becomes the profession to see that they are not out-stripped in this matter by their lay brothers. We shall here briefly indicate the chief points requiring attention; practice must do the rest.

Fractures—(A.) Of the Lower Limb.—It is of great importance to decide at once whether or not a fracture is probably or possibly present, because fixation of the broken bone should be ensured before the injured person is lifted or disturbed.

The *Diagnosis* must be made chiefly from the helplessness of the limb, the pain, and the distortion, as it is not always advisable to test for crepitus, if it should not be manifest on the first gentle handling. In doubt, treat as if a fracture were present.

The great secret in handling a fractured limb is to keep up extension upon it, until the splints be applied.

(*a.*) *Extemporary Splints*, it is needless to say, may be of any material that will give the necessary stiffness. For shorter splints, a mass of folded paper of any kind does very well, or a folded coat, sacking, or other stout cloth. Nothing is better than the straw envelopes used for packing bottles. Pieces of fire-wood, old wooden or pasteboard boxes broken up, walking-sticks, and umbrellas, are also generally available.

A capital splint may be made by knotting together pieces of wood, wisps of hay or straw, or bundles of twigs. This is used in the army, and makes a splint which closely imitates Gooch's, adapting itself easily to the limb (Fig. 129). For binding the

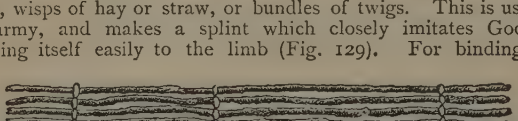


Fig. 129.—Extemporised Splint made from Twigs knotted together.

splint in position, handkerchiefs, cravats, twine, or rope, may be used.

It will be found an additional security (especially in fracture of the thigh, or where the patient has to be carried a long distance) to utilise the sound limb by fixing it to the injured one after the splints have been applied. Three bands are generally enough—one at the ankle, another at the knee, and the third round the thigh. In addition, a board may be fastened below the legs, to make all secure (Fig. 130). A long splint may be extemporised from a

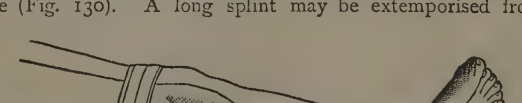


Fig. 130.—Steadying the Lower Limb.

broom-stick, or any other piece of wood or metal which is about the right length.

(*b.*) *How to lift and carry the Patient.*—Supposing a fracture to have occurred on the street, and the injured limb to have been secured with temporary splints—the next matter is to lift the patient, and carry him to his house or the nearest hospital. A patient thus injured may be carried (1) in the arms; (2) on a blanket; (3) on an extemporised stretcher.

(1) *In the arms.*—Three or (if available) four bearers are required to carry a patient in the horizontal position.

Getting into position.—While the patient is still on the ground, the bearers range themselves on his sound side (say, his right), and stooping down, put the left knee (in every case) on the ground with the right foot near it. No. 1 is opposite the shoulder, and placing his left arm beneath the right shoulder, leans across and passes his right arm under the patient's left axilla, and tries to meet his hands beneath; the patient at the same time, if able, clasps No. 1 round the neck and shoulders. No. 2, also on the right side, passes *both* arms well below the patient's pelvis. No. 3, still on the same side, passes one arm below the thighs, and the other below the legs. If there be a No. 4, he goes to the opposite side, and helps to lift the trunk and thigh, by passing his arms below.

First Stage.—When all are ready, No. 4 (or whoever is taking the lead) gives the word to lift. The patient is then raised from the ground, and supported on the right knees of the bearers, which, from the position assumed, project as a convenient support.

Second Stage.—A stretcher, if available, should now be placed beneath the patient by No. 4, who then assists in lowering the patient into it. Should there be no stretcher, the bearers, having adjusted their hold in the first stage, can then more readily rise to the erect position in the second, and carry the injured person to a place of safety. As this is a fatiguing mode of carrying to all concerned, it should not be attempted for more than one or two hundred yards.

Where only two bearers are available, the patient must be carried in the sitting position, by the two-, three-, or four-handed seat. The four-handed seat is best when the patient can clasp his bearers round the neck; the two-handed seat is available when two bearers have to carry a nearly unconscious patient; and the use of the three-handed seat is for an intermediate condition.

Four-handed Seat (Fig. 131).—The bearers place themselves on each side of the wounded person, facing obliquely towards him, and stooping down. Each grasps his own left wrist with his right hand, and with his left hand grasps the right wrist of the other bearer. The patient places himself on the seat thus formed, and puts an arm round the shoulders of each bearer as they rise to the erect position.

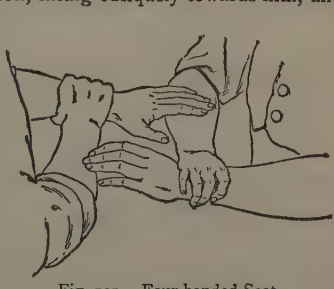


Fig. 131.—Four-handed Seat.

Three-handed Seat.—The bearers having placed themselves in the same position relative to the patient, the one on the right (No. 1) grasps his own left fore-arm with his right hand, and with his left

hand he grasps the left fore-arm of the other bearer, No. 2, who at the same time uses his left hand to take hold of the right fore-arm of No. 1. The patient is placed on the seat thus formed, and steadying himself as well as he can with his arms (as in the four-handed seat), he is still further supported by the free right hand of No. 2, placed behind him, and grasping the back of the coat of No. 1.

Two-handed Seat (Fig. 132).—The bearers having placed themselves as before, kneel on the knee which is to the front (right of No. 1, and left of No. 2), and placing their hands beneath the patient's arm-pits, raise him into a half-sitting posture against their other knees. They now pass their front arms beneath his thighs, and locking the fingers together with the palms uppermost, form a support for him. Their other hands are now made into a back-support, each grasping the other wrist. Rising together, they lift the patient, and proceed to carry him off.

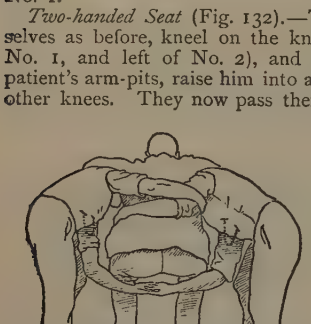


Fig. 132.—Two-handed Seat.

The great secret of all these seats is for the bearers to press strongly together, by so doing the ease of carrying is greatly increased.

2. *On a Blanket, Rug, or strong Sheet.*—Two bearers on each side are required; the blanket having been spread out below the patient, its side edges are rolled on themselves, close up to his body. The contiguous hands of the bearers on each side grasp the rolled blanket about opposite the patient's loins, while with their other hands they seize it, opposite his shoulders and knees respectively. They can now easily lift him. If he be unable to support his own head another person must attend to this, or the blanket must be seized higher up. A stiff rod or pole, if rolled into the edge of the blanket, increases the facility of lifting.

3. *On a Stretcher.*—Where a regular stretcher is not available, a substitute is easily made. If a shutter or a board is not to be had, a short ladder, wooden gate, or part of a fence, does very well. If two stout poles can be found, it will not be difficult to supply the necessary material to stretch between them. Ordinary ropes, or those made from twisted hay or other material, may be laced across from side to side, or holes may be made in the ends of sacks and the poles pushed through. Or again, cloth, sacking, &c., may be nailed to the poles. Coats may be used by turning the sleeves inside out, and buttoning the front of the coat over the poles. Two or three ordinary coats are required for this purpose. If an ulster be available, it will be still better. If a transverse bar to keep the

poles apart can be supplied, it will much facilitate the ease of carrying (Fig. 133).

Should it not be possible to find suitable single poles, strong walking-sticks or umbrellas can be used—if tied together with handkerchiefs or rope. Two extra assistants, however, will then be required. The handled ends of the walking-sticks are to be placed

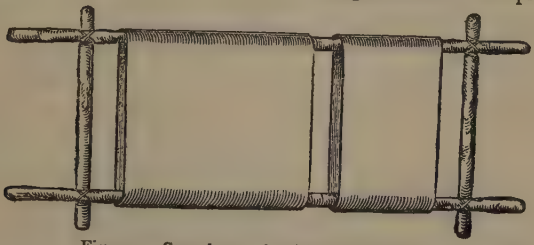


Fig. 133.—Stretcher made with Poles and Cloth.

together, and each firmly looped on to the end of a handkerchief. The coats or other material are then slipped over the sticks, the middle of the handkerchiefs being left out to be grasped, while (Fig. 134) the ferruled ends of the sticks project in front and behind

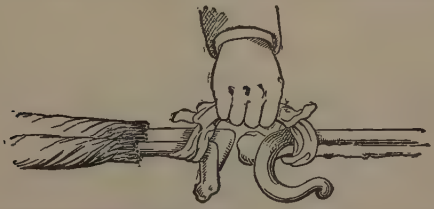


Fig. 134.—Mode of utilising Sticks, &c., as Stretcher Poles.

to be grasped by the front and back bearers. No attempt is made to *splice* the sticks, and so assistants must lift their attached ends.

B. Fractures of the Upper Limb—Fore-arm, or Upper Arm.—Any thick fold of cloth or paper, or a piece of wood or metal, will keep the bones steady until regular appliances can be obtained.

A *sling* is very easily made from two ordinary pocket-handkerchiefs, by tying one loosely round the neck, and after laying the fore-arm diagonally on the other, tying its two side corners within the first (Fig. 135).

Other slings may be made by folding up the side of a coat, and pinning or buttoning it in position, ripping up the seam of the sleeve, and folding it over the arm, or suspending the limb with a cravat or sash.

If the *clavicle* be broken, all that is needed is to support the elbow well by an extemporary sling, and bind the arm to the side. Should the handkerchief round the neck press upon the broken bone, the two ends of handkerchiefs must be knotted together. One handkerchief is then placed over the sound shoulder, while the other, spread out, and passing below the elbow of the injured side, is carried to the back to be fastened there to the free end of the first handkerchief.

A fractured *lower iaw* requires to be supported by pressure from below against the upper jaw. A handkerchief round the chin will be found sufficient.

C. Bleeding Wounds. — In the extemporary treatment of bleeding wounds, whether with or without a fracture, there are three objects to be kept in view, viz. :—(1) Stopping the bleeding; (2) Covering up the wound; (3) Fixing the part to ensure rest.

Fig. 135.—Pocket Handkerchiefs used as Sling.

The first and second indications may often be combined by fixing a firm pad over the wound. As dry absorbent wool charged with an antiseptic is not likely to be available, any clean dry piece of cloth may be used instead. If an antiseptic be not at hand to cleanse the wound, should it be evidently dirty, boiled water will be at least a-septic, as will be any rags or cloths wrung out of boiling water; if applied hot to the wound,

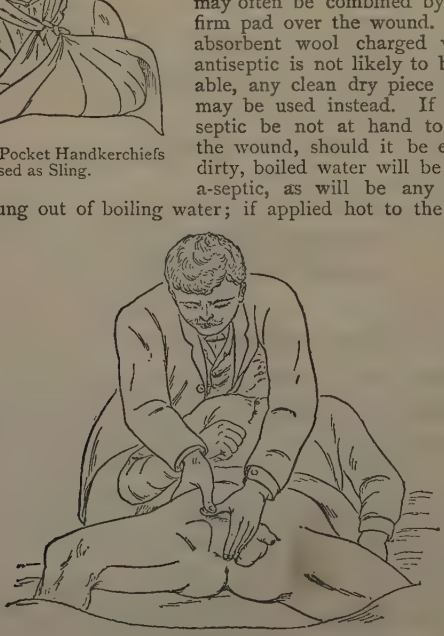


Fig. 136.—Digital Compression of Femoral Artery.

they will have, in addition, a hæmostatic effect, and should replace the dry rag. (*N.B.*—Although a recently washed and clean cloth is not necessarily a-septic, it will be more nearly so than one which has been collecting dust from all sides since it left the washing-tub.)

Domestic Antiseptics are:—Turpentine (also an excellent hæmostatic), and alcohol in the form of spirits, strong wines, or methylated spirits of wine; treacle or golden syrup, or a syrup of ordinary sugar; glycerine. Powdered charcoal, or sulphur, is also efficacious, and is often to be had.

In some country-places peat-turf is abundant. This has been largely used in Germany for wound-dressings. It should be crumbled fine, freed from lumps, and applied to the wound in bags of muslin, if possible.

Bleeding from an Artery.—When a large artery is wounded, and direct pressure upon it is not possible, the bleeding must be controlled by digital compression (Fig. 136*), or by a tourniquet. An extemporary one may be made from any scarf or piece of rope, as follows (Fig. 137):—Knot the band round the limb so loosely that the fingers may easily pass beneath the band; take a piece of strong stick and twist it into the loose band; then take a piece of paper and lay it on the skin just below the stick, to prevent the skin being nipped in; now, twist the stick round until the band is sufficiently tight. If a handkerchief or scarf be used, a stone or other firm substance may be folded into it to form a pad over the main vessel of the limb. It should never be forgotten that the pressure of a tourniquet, though sometimes necessary, is always more or less injurious, and in five or six hours is likely to kill the tissues below the point where it is applied.

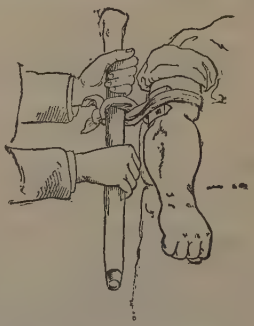


Fig. 137.—Extemporised Tourniquet.

(3) The third object, *fixation*, should be ensured by applying an extemporary splint to the limb after the bleeding has been stopped and the wound occluded.

Rules for Bearers of the Wounded.—The rules given in military works for carrying wounded men on stretchers are:—

(1) To place the patient towards the injured side, in a wound of the chest or lower limb.

(2) Towards the sound side, if the upper limb be injured.

(3) On his back with legs drawn up, if the abdomen be wounded.

These indications may also be of service in carrying hospital patients to and from the operating-theatre. The front bearer in carrying a stretcher should be *out of step* with the rear bearer, to

* See p. 56.

prevent a disagreeable swing. It is better generally to carry the feet foremost; but in going up a hill, the patient's head should be towards the top, unless the injury be a fracture of the thigh, in which case the injured limb is uppermost.

Formation of Ambulance Classes.

Practitioners in country districts are frequently asked to undertake a course of Ambulance Lectures, and from want of special training in ambulance work are often at a loss to know how to proceed. If they can arrange the matter with their pupils, practitioners in such a position should form a local branch of one or other of the existing Ambulance Associations—*e.g.*, of the St. John's Ambulance Association in England, or of the St. Andrew's Ambulance Association in Scotland. If they put themselves in communication with the secretary of either Association,* they will be furnished with full instructions "how to form a class," and will be able to get the loan of a Skeleton, a Stretcher, Diagrams, and the other necessary apparatus.

Should no such formal work be desired, the practitioner cannot do better than take as his basis the Syllabus laid down by one or other of these Associations, and make such modifications as the circumstances of his case may seem to indicate.

The following is the Syllabus of Ambulance Lectures as laid down by the St. Andrew's Ambulance Association:—

SYLLABUS OF AMBULANCE LECTURES.

First Lecture.—A. Introductory remarks, explaining clearly the scope and object of lay help in ambulance work, special attention being drawn to the need for it, as well as the usefulness and simplicity of it.

B. Short sketch of the general anatomy of the human body, including a brief description of the functions of digestion, absorption, circulation, respiration, excretion, secretion, and innervation.

C. Uses of a bandage—Of the two kinds of bandage, the roller not needed for ambulance work—Description of Esmarch's triangular bandage, pointing out (1) its advantages, (2) method of folding it and fastening it, (3) its application in different ways —Hints as to the "first dressing" of wounds by ambulance pupils.

Second Lecture.—A. Short account of the skeleton, with brief description of the structure and varieties of the joints.

B. (1) *Fractures*—Their varieties, causes, symptoms, and dangers—Their temporary treatment and the apparatus necessary for it. (2) *Dislocations*—How they differ from fractures, and the first aid in such cases—No necessity for immediate reduction, and the dangers of attempted reduction by non-professional persons.

* Address:—Secretary, St. John's Ambulance Association, St. John's Gate, Clerkenwell, London.
Address:—Secretary, St. Andrew's Ambulance Association, 93 West Regent Street, Glasgow.

C. Illustrations of the temporary treatment of the following *simple* fractures—(1) collar bone, (2) upper arm, (3) fore-arm, (4) the hand, (5) thigh, (6) leg, (7) foot, (8) lower jaw.

Third Lecture.—To be devoted to practical work, when the members of the class will exercise themselves in the use of the triangular bandage and the temporary treatment of the different fractures mentioned in the previous lecture.

Fourth Lecture.—A. (1) General description of the circulation of the blood, and the mechanism by which it is carried on—(2) Distinction between arterial, venous, and capillary hæmorrhage—(3) Names of the main arteries of the body, with their situations—(4) Points where arterial circulation may be arrested by pressure—(5) Dangers of hæmorrhage.

B. General treatment of hæmorrhage:—I. *Internal hæmorrhage*—First aid in cases of (1) bleeding from the nose, (2) spitting of blood, (3) vomiting of blood. II. *External hæmorrhage*—(1) Application of cold, either by water or exposure to air—(2) Elevation of part—(3) Local pressure—(4) Distant pressure on main artery supplying wound, either by hand or tourniquet—(5) Three kinds of tourniquet: elastic, screw, and improvised.

C. Show mode of applying elastic or screw tourniquet, and of making an improvised one—Give illustrations of arrest of hæmorrhage from (1) scalp, (2) neck, (3) armpit, (4) upper arm, (5) fore-arm, (6) hand, (7) thigh, (8) ham, (9) leg, (10) foot—Give illustrations of temporary treatment of a *compound* fracture, with hæmorrhage in upper or lower extremity.

Fifth Lecture.—To be devoted to practical work, when the members of the class will exercise themselves in the arrest of hæmorrhage in various situations, and in the temporary treatment of *compound* fractures.

Sixth Lecture.—A. Short account of respiration, its objects and mechanism.

B. Fainting, its causes, symptoms, and treatment—Immediate treatment of those apparently drowned, or suffocated by (1) hanging, (2) poisonous gases, (3) choking—First aid in cases of (1) burns and scalds, (2) bites by animals possibly rabid, (3) tears from machinery, (4) crushed and bruised parts, (5) stabs.

C. Show mode of performing artificial respiration (Sylvester's method), and also the temporary treatment of fractured ribs.

Seventh Lecture.—To be devoted to practical work, when the members will exercise themselves in performing artificial respiration, and in the arrest of hæmorrhage from supposed cases of ruptured varicose veins, stabs, tears from machinery, and gunshot wounds.

Eighth Lecture.—A. Short account of the nervous and digestive systems.

B. Symptoms and first treatment of shock or collapse.

C. First aid in cases of (1) those stunned by a fall or injury to the head, (2) of convulsions, (3) of epilepsy, (4) of sunstroke, (5) of persons found insensible, (6) of suspected poisoning, (7) of frost-bite, (8) of lime in the eye, (9) of supposed death.

Ninth Lecture—for Males only.*—A. Removal of Injured by means of stretchers, special attention being directed to (1) the proper carriage of the stretcher, (2) the manner of placing it, (3) the loading and unloading it, (4) the position of the patient on it, (5) suggestions as to overcoming difficulties on the road, (6) hints as to the conveyance of stretchers by rail or country carts.

B. Short account of some of the improvised methods of removing injured persons when no stretchers or regular conveyances are available, as by the two-handed, three-handed, and four-handed seats.

C. Give illustrations as to how to prepare and fold up a stretcher.

Tenth Lecture—for Males only.*—Stretcher drill in presence of and under direction of Lecturer.

SYLLABUS OF LECTURES TO WOMEN ON HOME NURSING AND HYGIENE.

I. THE SICK-ROOM.—Introductory Remarks. The Sick-Room—its Selection, Preparation, Cleaning, Warming, Ventilation, and Furnishing—Bed and Bedding.

II. INFECTION AND DISINFECTION.—Infectious and Non-Infectious Cases—Quarantine of Patient—History of a Fever Case—Disinfecting and Disinfectants.

III. DETAILS OF NURSING.—The Nurse: Management of Nurse's own Health—Regulation of Visitors—Washing and Dressing Patients—Bed-making—Changing Sheets—Lifting Helpless Patients.

IV. DETAILS OF NURSING.—Sick Diet: Administration of Food, Medicines, and Stimulants—Observation of the Sick as to (1) Rigors, (2) Sleep, (3) Pain, (4) Posture, (5) Skin, (6) Appetite, (7) Vomiting, (8) Cough, (9) Expectoration, (10) the Effects of Remedies.

V. DETAILS OF NURSING.—Taking of Temperature—Baths—Bed-Sores—Delirium—Nursing Sick Children—What to prepare for the Physician's and Surgeon's visit.

VI. APPLICATION OF LOCAL REMEDIES.—Poultices—Fomentations—Blisters—Ointments—Leeches—Padding—Splints—Bandaging—Personal and Family Hygiene—Management of Convalescents.

Should more information be desired, consult one or other of the numerous Handbooks in existence.†

* In Ladies' Class, Lectures on Sick Nursing will take the place of these Lectures.

† Such as *The Ambulance Pupil* (Crosby, Lockwood & Co.); *Aid to the Injured and Sick*, by Dr. Gill (Allman & Son); *Common Accidents*, by Dr. Andrew Wilson (Chatto & Windus), &c., &c.

CHAPTER XIX.

MASSAGE.

Contents.—Utility of Massage—Physiological effects produced by it—Objects aimed at in the use of Massage—Movements employed: (*a.*) "**Stabile**" (Pressing, Hacking, Thrusting, Tapping, Pinching)—(*b.*) "**Labile**" (Stroking, Kneading, Rubbing)—Time to be occupied at each Sitting—The *Effleurage-Pétrissage-Effleurage* sequence—Surgical conditions in which Massage will be beneficial—Caution.

ALTHOUGH the term "massage" has been objected to, as now meaning more than merely "kneading," still it is a convenient word to express those manipulations of muscles, joints, and other parts, which are often so very useful as a means of treatment.

It seems right in a work of this sort to explain the methods employed, and indicate generally their applications to disease, for there can be no doubt that "massage" is invaluable in certain cases, and no well-educated surgeon or physician should be ignorant of its general principles.

Many are deterred from studying the subject by the assertion that no one can learn it without special personal instruction. Schreiber, however, in his eminently scientific *Manual of Treatment by Massage*, says as to this, that "the necessary knowledge and skill can very well be mastered *without* an instructor, if, with each manipulation, the final end, namely, the physiological effect, be kept strictly in view."

Physiological Effects.—What, then, are these physiological effects?

1. Soothing and gentle stimulation of *cutaneous nerves* by stroking the skin.

2. Encouraging venous and lymphatic *circulation* by stroking towards the heart. The vessels reached will depend on the part and on the depth of pressure. Following from this, there results increased activity of the circulation of the part so treated, *i.e.*, dilated arteries and capillaries, and a more rapid current of blood, and, in consequence, increased warmth, more active nutrition, and the removal of effused material. Muscles after massage have their electrical conductivity as well as their voluntary motor power greatly increased, and they recover from exhaustion much more rapidly than when left to themselves.

3. Mechanical stimulation of the *tissues*, leading, probably, to molecular changes, and resulting in increased activity of circulation and of metabolism. The tissues most usually affected besides the blood-vessels are the muscles, nerves, and in pathological conditions, inflammatory exudations. There is no reason why gland-tissues might not be affected in a similar way.

Objects aimed at in Massage.—These effects of massage are applied—

1. To stimulate the circulation locally or generally; increase metabolism, and encourage nutrition, whether in special groups of muscles, or in the body as a whole. Also to equalise the circulation, and draw blood away from congested areas (*e.g.*, shampooing to induce sleep).

Eccles* has shewn that superficial centripetal rubbing increases the pulse rate, probably by returning the blood more rapidly; while deep muscular shampooing slows the pulse, probably by dilating the vessels in the muscles.

2. To promote absorption of recent or old-standing inflammatory products, and to remove recent effusions of chronic thickenings and adhesions. These latter may be in and around joints, muscles, glands, or nerves, producing corresponding results.

3. By exciting molecular changes to remove certain neuralgias, *e.g.*, some forms of sciatica, and myalgias of the recent rheumatic or lumbago type.

4. Owing to its influence in stimulating the circulation and increasing metabolism, it forms part of the treatment of advanced hysterical emaciation, and has been advocated in narcotic poisoning, and for those apparently drowned. Although an almost endless

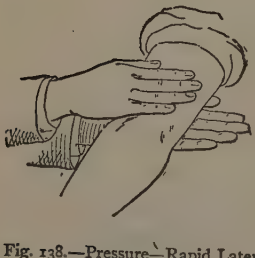


Fig. 138.—Pressure—Rapid Lateral Movements.

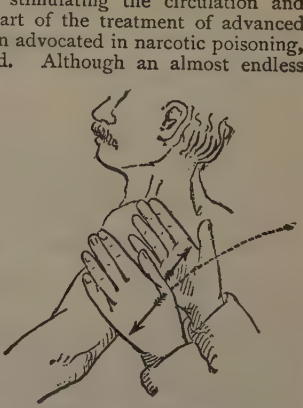


Fig. 139.—"Hacking."

number of methods of manipulation have been advocated, the chief ones only need be described here.

The Movements employed.—The simplest subdivision of the movements is that adopted by Schreiber, who classifies them as "stabile" and "labile." Under the first he includes pressing, tapping (or beating), hacking, pinching, and concussing; under the second, stroking, rubbing, and kneading.

(*a.*) Stabile Movements.—(1) "Pressing" may be done with the

* *Practitioner*, 1887, vol. i.

tip of one or more fingers, with their phalanges (especially 2nd), or with the knuckles. The simple pressure may be modified by lateral or rotatory movements, or by passing into a rubbing or kneading movement. The amount of pressure employed will vary with the depth to be reached, and the object to be attained (Fig. 138).

(2) "Tapping, thrusting, hacking" (*i.e.*, "*Tapotement*") indicate sudden effects produced more or less forcibly. "Tapping" is done with the pulp of the fingers from the wrist, as in percussing the chest, or by knocking, as at the door, with the knuckles. "Thrusting" is really poking up the deeper parts with the tips of the extended fingers, knuckles, or with the closed fist. "Hacking" is just striking the muscles with the ulnar edge of the opened hand or fingers, according as more or less force is required. It is used in dealing with the larger groups of muscles, and with deep nerves (Fig. 139).

(3) "Pinching," as its name denotes, is a grasping of the soft parts, either with the tips of the thumb and fingers, or with the pulp of the same. This is applied specially to muscles and groups of muscles. A series of pinches following one another along the muscles in a centripetal direction is said to force onwards the venous blood and lymph. This may result to a certain extent. Those who insist most, however, on the necessity for anatomical knowledge in the masseur, seem to forget that to a certain extent in all muscles, and very markedly so in some, the blood-vessels enter the muscles at certain points from which they afterwards radiate. We would, therefore, believe that the chief value of this manipulation is the mechanical disturbance produced.

Figs. 140 and 141.—"Pinching."

A modification of pinching consists in "squeezing" the tissues between the ball of the thumb and the tips of the fingers, after the fashion of what schoolboys term a "Horse bite"—one of their numerous forms of mild torture.

(*b.*) **Labile Movements** comprise stroking, rubbing, and kneading.

(1) Centripetal stroking or "milking," when applied to the veins and lymphatics, is known as "*effleurage.*" This increases the circulation, and aids absorption. It precedes and follows most other movements to clear out the main trunks and prepare for their being

filled, and afterwards to sweep away accumulations within them.* It is carried out either with the flat of the hand or with the edges of the spread-out forefinger and thumb, followed up with the palm of the hand. Muscles and groups of muscles are to be so treated as well as the subcutaneous textures.

(2) Friction, "kneading" (*Pétrissage*), or rubbing proper, consists in firm pressure moved over special spots. It is specially applicable to inflammatory thickenings, in and round joints and tendon sheaths, and in the substance of muscle. It may be done with the finger-tips or knuckles: but the pulp of the thumb will be found specially useful. The operator tries to dispel the thickening, as if by his own efforts, although he knows that probably the chief benefit will result from the after-vital changes which he sets up.

Time Necessary.—The time to be occupied at each sitting is a matter of opinion. Dr. Grant, writing after a visit to von Mosengeil's Clinique, believes that in Britain the period is generally too much prolonged. His view is "That when once the muscles have been fairly and completely emptied of venous blood, lymph, and waste products, and when once an active afflux of arterial blood has been established, nothing more can be done for the time." In general massage, "every muscle should be subjected to *two successive processes of effleurage-pétrissage-effleurage*," and this he holds should be done by rapid movements in from 10 to 15 minutes. In local massage, about the same time may be occupied, except where inflammatory thickenings have to be got rid of, when a somewhat longer time may be taken. Once a day is generally considered sufficient.

Surgical Conditions in which Massage is applicable.—The commoner surgical conditions in which massage will mostly be required, are:—

(1) *Stiff Joints*, resulting from prolonged fixation for any reason, or following simple inflammation in and round the joint.

(CAUTION.—*The stiffness following "strumous" arthritis is generally in old, and always in recent cases, best left alone, lest the original mischief should be re-excited.*)

In these cases, the massage is applied to get rid of inflammatory thickenings, and to stimulate the growth and activity of muscles, which have been atrophied from disuse. To massage must be added hot and cold douching over the joint and muscles, progressively increased passive and active movements, and faradisation.

(2) *Inflammatory Thickenings* in any accessible part—*e.g.*, round urethral strictures, in callous ulcers, in the testis after orchitis, &c.

(3) *Rheumatic Contractures and Thickenings*, where similar applications are made upon the affected muscles and the skin over them.

(4) *Recent Effusions*, to promote absorption by effleurage. Some also advise the promotion of absorption of synovial distension in the same way.

* Grant, *Edin. Med. Journal*, Aug., 1887.

CHAPTER XX.

SURGICAL APPLICATIONS OF ELECTRICITY.

Contents.—Various Forms of Electricity Employed—Mode of Producing the Electrical Current—The "Galvanic," and the "Faradic" Current — Electro-Diagnosis — Electro-Therapeutics — Caution — Selection of Current—Duration of the Application—Motor Points—Mode of Application—Electrolysis—The Galvano-Cautery.

COMPARED with its uses in Medical practice, the applications of Electricity to Surgery are less extensive, besides being chiefly of a different kind. For full information on "Medical Electricity," we must refer our readers to some of the special works on the subject. In the present chapter we shall only attempt a brief explanation of some of the more important practical applications of Electricity to Surgical practice.

The **Forms of Electricity** employed are the **Galvanic**, or Chemical, current, allowed to remain continuous, more or less slowly interrupted, or occasionally reversed, and the rapidly interrupted induced **Faradic** current. The terms "Galvanic" and "Faradic" are derived from the name of the discoverer of the special form of current in each case. Electricity is the same thing under all circumstances, but it differs in its effects according to the way in which it is produced.

Before we speak, however, of the applications of current electricity, we must understand the mode in which it is produced.

Mode of Producing the Electrical Current.—The Galvanic Current is obtained from some form or other of "cell" or "element." This depends for its construction on the fact that when two dissimilar metals, or a metal and carbon, are immersed in a corrosive fluid, and either touch at one point or are united by a connecting-wire, an electrical current is established in the "Circuit," which is the term used to express the combination of metals, fluid, and connection. One such arrangement is called a *galvanic cell* or *galvanic element*, while a number of cells coupled together form a *battery* or *pile*.

The metal more easily attacked by the fluid is corroded, while bubbles of hydrogen gas form on the other. The current is said to begin at the corroding metal, pass through the fluid to the other metal or carbon, thence through the latter, and back to the first metal by the point of junction or by the connecting-wire. The outer portion of the current—*i.e.*, that which flows along the connecting-wire, is that which is used for medical and other purposes. The points of attachment of the connecting-wire to the metals are known as the *Poles* of the cell. That Pole *towards* which the current flows in the outer part of the circuit is called the negative (−) pole, while the other *rom* which it comes, is called the positive (+)

pole. Metals have been arranged in order according to the ease with which they are attacked. Thus, in dilute sulphuric acid, the order would be amalgamated zinc, ordinary zinc, iron, tin, lead, copper, silver, platinum, and carbon. The further apart the metals are in the series, the greater the difference in their "potential"—*i.e.*, the greater the tendency for a current to flow from the one to the other in a "cell."

Electro-Motive Force is the magnitude of the cause which produces the electric flow. It will, of course, vary with the metals chosen, and with the fluid in which they are immersed. Amalgamated zinc is generally chosen for the negative pole metal or *negative* plate; copper, silver pure or platinised, or carbon, for the other or *positive* plate.

As the cell works, a layer of hydrogen gas tends to gather on the positive plate, a process which is called *polarisation*, and which is important because its effect is to interfere with the original current by sending one in the reverse direction. Polarisation is a frequent cause of disorder in batteries. To obviate it (1) the positive plate is made rough, so that the hydrogen may form air-bells and escape by rising to the surface. (2) Some substance which absorbs hydrogen by uniting with it is interposed between the two plates—*e.g.*, binoxide of manganese in the Leclanché cell, bichromate of potash in the Grenet cell, sulphate of copper in the Daniell cell, &c.

The electro-motive force is always the same for the combination of any two metals immersed in a given fluid to form a cell, however large or however small the surface of metal exposed to that fluid be. It has been likened to the "head" of water, which is always the same for a given height to which a quantity of water may be raised, however any other conditions as to size of pipe, &c., may vary. The electro-motive forces of a number of cells can be superposed by coupling the cells together *in series*—*i.e.*, connecting the positive plate of one cell to the negative of the next, and so on; thus multiplying the electro-motive force by the number of cells employed.

The flow of Electricity is always more or less resisted, both within the cell (*internal resistance*), and there especially in the corroding fluid, which acts as a conductor; and also outside the cell (*external resistance*), in the wire or other conductor, which unites the two poles. The resistance, like that of a pipe to the flow of water through it, is in inverse proportion to the cross-section of the conductor, and in direct proportion to its length. Thus, the smaller the cross-section of the conductor, and the longer it is, the greater will be the resistance which it offers to a current of electricity, and *vice versâ*. Hence, the larger the "plates" of a cell, the greater the cross-section of the fluid conductor between them, and so the less the "internal" resistance of the cell—a factor which can be still further diminished by bringing the "plates" nearer together. When the cells of a battery are united, not "in series," but "*in surface*"—*i.e.*, with all the positive poles, and all the negative poles joined to one another, the electro-motive force remains as that of a single cell, but

the internal resistance is diminished just as if the plates of a single cell had been enlarged as many times as there are cells in the battery. In such a case, any one of the coupled-together positive poles, and any one of the coupled-together negative poles, will serve as the positive and negative pole of the battery. When desired, the cells may be united "in surface" into groups of so many cells, the electro-motive force will then be multiplied by the number of groups, while the internal resistance will be diminished in proportion to the number of cells in each group. Thus, a battery of 30 cells may either be arranged entirely "in series," entirely "in surface," or into groups, say into two groups of fifteen cells each, into three groups of ten each, and so on.

The current strength (c) of a cell or battery, according to Ohm's law, varies directly with the total electro-motive force (E), and inversely with the total resistance [internal (ir), and external (er)], and is usually expressed thus —

$$c = \frac{E}{er + ir}.$$

When the electro-motive force is multiplied, say, 10 times, by coupling together 10 cells in series, the internal resistance, which belongs to each cell, is also multiplied to the same extent; but when the external resistance to be encountered by the current is very much greater than the internal resistance of the cell, this increased internal resistance may be neglected in comparison to the gain in electro-motive force attained by multiplying the cells in series. Hence, in passing currents of Electricity through the human body, where the "external" resistance is enormous, the cells of a battery must be multiplied in number and arranged in series. On the other hand, when external resistance is comparatively slight, as in electrolysis of aneurisms, or of vascular tumours, or in the galvano-cautery wire, advantage is gained by diminishing the internal resistance; and this, as we have seen, is to be attained by increasing the size of the plates of the cells, or arranging the cells of a battery into groups, where like poles are united. Hence, for ordinary surgical electrolysis operations, or galvano-cautery work, as well as for the incandescent lamp of the cystoscope, a few large cells, or a few large groups of small cells, are what are needed. For electrolysis of uterine fibroid tumours by Apostoli's method, great electro-motive force, and consequently a large number of cells, in series, are needed.

In order to compare the strength of various currents, certain standards have been agreed upon by electricians. These are expressed as Volts, Ohms, Ampères, and Milliampères.

A **Volt** is the unit of electro-motive force. The electro-motive force of a single Daniell's cell is about 1 volt.

An **Ohm** is the unit of resistance to electric currents. It is the resistance of a column of mercury about 1 metre long and 1 square millimetre in section.

An **Ampère**, the unit of current, is that which 1 volt produces in a conductor of 1 ohm resistance.

A **Milliampère** is the thousandth part of an ampère. Milliampères are the standards usually referred to, when currents for medical or surgical purposes are spoken of.

A **Galvanometer** is an instrument used to measure the current which flows in any circuit. By its means, we are enabled to distinguish between the theoretical power of a battery and the actual current which at any given moment it is able to send through a conductor in the face of resistance. Its construction depends upon the fact, that a finely-poised magnetic needle, if surrounded by a coil of wire, is deflected from its position, pointing north, when an electric current flows through the coil of wire. The stronger the current, the greater the deflection. By careful experiment, the degrees of deflection can be marked as equivalent to so many milliampères. Except for the electrolysis of superficial tumours (as afterwards explained), this instrument should be interposed in the circuit whenever the continuous current is applied for any purpose to the human body, as by its use alone is any approximation possible to the dosage of Electricity employed. A perfectly accurate measurement of the amount of Electricity which passes through the tissues does not seem attainable, owing to polarisation within the body and other sources of loss, which cannot be correctly estimated. With a galvanometer, however, we get the best possible approximation.

Electrodes are the terminals, connected with each pole of the cell or battery, which are applied to the body. They may be in the form of tubes holding a piece of sponge, or of variously shaped and sized pieces of carbon, covered with wash-leather. The larger the electrode, the more diffused the current which it transmits, and *vice versâ*. Since the epidermis, when *dry*, is an extremely bad conductor, electrodes applied to the skin must be thoroughly moistened with water, plain, acidulated, or with a small quantity of common salt dissolved in it. For ordinary electrolysis, the electrodes should be in the form of needles insulated with vulcanite to within half-an-inch of their points.

Rheophores are the two connecting-wires between the poles of the battery and the electrodes. They are generally made of copper wire, and are insulated with guttapercha or with silk. Sometimes they are differently coloured, so that a glance may tell to which pole they belong.

A **Rheostat** is an instrument employed to resist a current of electricity in a given and known way. Rheostats are made so that a known number of ohms' resistance may be interposed in a current. They are used as a means of gradually altering a current, since it will become either stronger or weaker as less or more resistance is interposed. A steadier current also is obtained from a number of cells strongly resisted, than from a few cells with little or no resistance.

Induced or Faradic Current.—This depends upon certain physical laws by which (1) when a current of electricity from a cell or battery flowing along a coil of wire is suddenly interrupted, an instantaneous reverse current is at once "induced," and runs through

the wire in the opposite direction to the first. (2) When a second coil of wire is placed outside the first, and when in the latter a current is alternately allowed to flow and is interrupted, sudden currents are "induced" and run through the second coil in the reverse direction to those in the first or inner coil. The intensity of the induced currents in the second coil increases with the number of turns of wire which this coil contains and with its proximity to the first coil. In the faradic apparatus a special mechanism is provided for automatically and rapidly making and breaking the first current. By adjusting the rheophores the induced current from the first, or both currents from the second coil, may be passed through the electrodes. When the rheophores are attached to the first coil, only the induced current passes through them—for reasons that we need not stop to discuss. The current thus utilised is therefore rapidly interrupted in one direction. When, however, the rheophores are connected with the outer or second coil, both currents—*i.e.*, those in opposite directions—are passed through the electrodes. For this reason (and also because these currents are generally intensified by numerous turns in the second coil) the physiological effects produced by the currents from it are greater than those produced by the first coil.

A *Magneto-faradic* machine is sometimes used instead of the faradic current. The construction of this apparatus depends on the fact (1) that alterations in a magnet are produced by a bar of soft iron being brought near and then removed away from it, while at the same time the iron bar is itself magnetised and demagnetised in the process. And (2) that if the poles of the magnet and the iron bar are each surrounded by a coil of wire, each of the above changes is accompanied by the development of an induced current of electricity in the surrounding coils. By turning a handle in one of these machines, two iron bars are made to revolve rapidly past the poles of a fixed magnet, and, by special arrangement of coils of wire, the currents thus induced in them can be led in to the rheophores to which electrodes are attached. The apparatus requires no galvanic cell, but needs some one to turn the handle, and for this reason, as well as because the shocks are found to be rougher, it is less used than the faradic apparatus. It is, however, not liable to go out of order, and may be used in hospitals where assistants are generally easily procured.

Electro-Diagnosis is based upon variations which, in certain diseases of the nervous or muscular system, occur in the kind and extent of response of muscles to stimulus, applied by electricity either to the nerve alone or to the nerve and muscle together. As the subject mainly belongs to medical cases, we shall not do more than thus merely mention it in passing.

Electro-Therapeutics. — In many cases of partial muscular paralysis, such as that from infantile paralysis, nerve lesion, or which follows long disuse from rheumatism, joint disease, or fracture, the application of Electricity may with advantage be combined with Massage (Chap. xix.) and hot and cold douching.

Caution!—When any lesion of the brain or spinal cord has caused

the paralysis, no electrical treatment should be employed until all central inflammation has subsided, because it has been found that peripheral stimuli to the nerves are transmitted in a greater or less degree to the centre, and so are apt to aggravate existing inflammation there.

Selection of the form of Current suitable for each particular case is, of course, greatly a matter of experience, but the general indication available to beginners has been simply and briefly stated by Wood (*Therapeutics*), thus :—"*Always select that current which produces the greatest number of contractions with the least amount of pain.*" In order to do this, we are then told to begin with "the rapidly interrupted faradic, or the rapidly interrupted chemical current, and always when these fail to elicit response the slowly-reversed chemical current, which, if necessary, may be increased in strength until the patient can no longer bear the pain." The rapid interruptions are made automatically by the interrupting apparatus, the slow interruptions and the reversal of the chemical current must be made by the operator's hand working the special mechanism provided for the purpose in the batteries as now sent out for medical purposes. Experience has shown that during the continuous passage of a current of electricity of moderate strength through a motor nerve, or through a nerve and muscle, no appreciable effect is produced ; but that when the current is suddenly interrupted, or suddenly allowed to pass again, a sudden contraction of the muscle takes place. This explains why a rapidly interrupted current produces more contraction of muscle than the same current flowing continuously. Further, it has been found that a "descending" current—*i.e.*, where the negative pole is applied nearer to the periphery than the positive pole—produces a greater effect than an "ascending" current, when the circuit is completed or closed—*i.e.*, when the current begins to flow; but that, on the other hand, an ascending current produces a greater effect than a "descending" current, when the current is suddenly interrupted. Also, it has been found that an alternately reversed current produces a greater effect than a current (even though interrupted) which flows always in the same direction. Hence the rules given above. Although it is probably not the actual contraction produced which is beneficial to an impaired muscle, still it has been found in practice that the currents which elicit contractions, as above stated, are those from which greatest benefit is obtained—while strong stimuli, which have ceased to elicit contractions, should be given up, as they have been found to do more harm than good. In many cases, the first signs of returning motility are slight voluntary contractions, even when electrical stimuli are powerless to produce any.

Duration of Application.—This will depend on the number of muscles to be stimulated, and on their condition. The weaker they are, the shorter time should they be treated with electricity. Fatigue of the muscle is always deleterious, and should be avoided. It is usual to stimulate for a few seconds each muscle of an affected group in succession. No one muscle should have more than five minutes in

all at the outside, and generally less. The sitting, which should only last for from ten to twenty minutes, may be repeated daily, or once or twice a week, according to circumstances.

Motor Points.—Duchenne, followed by Erb and others, has shown that on the skin over all superficial muscles there exists a special spot which yields the maximum of contraction, when an electrode conveying a given current is applied to it. These spots are called the "*motor points*" of those muscles, which respond to the stimulus thus applied. They should always be utilised in the application of electricity to muscles.*

Mode of Application.—For the *galvanic* current, one electrode, of large size, and for preference the anode (positive), should be placed against the patient's sternum or back, whilst the other electrode is pressed against the part to be stimulated. The size of the latter electrode will vary according to the concentration of stimulus required: thus, a single fine nerve, on the motor point of a small muscle, will require a small electrode firmly pressed down, and larger areas will need larger electrodes, but somewhat stronger currents.

For the *faradic* current, one electrode (either will do) is usually placed over the main nerve supplying the muscle, while the other is applied over its motor point.

Electrolysis is the term applied to the decomposition of water, or other fluid or soft solid medium, by the passage of a strong current of electricity through it. The medium decomposed is known as the *electrolyte*, and when this happens to be water, hydrogen gas is found to gather round the negative pole, and oxygen round the positive pole. When the electrolyte is an organic fluid, such as blood, small quantities of strong alkali are found round the negative pole, and small quantities of strong acid round the positive pole. These minute quantities of acids and alkalies produce their characteristic effects upon the tissues, but have never been found carried into the general circulation.

It is to this their local action, especially that of the negative pole, that J. Duncan attributes the benefit of electrolysis for vascular tumours and goitre, while the destructive effect of the negative pole has also been recommended for the dissolution of urethral and other strictures.

The cases in ordinary practice, for which (according to J. Duncan) electrolysis is best suited, are—subcutaneous nævi on exposed parts of the body, where therefore a scar is undesirable, cirsoid aneurisms, and intra-thoracic sacculated aneurisms not amenable to other treatment. The same authority has also obtained good results in many cases of goitre.

The methods employed are similar in the above cases.

The battery should consist of from three to six large cells, such

*Although their relative position will vary slightly in different individuals, still with a few trials they will soon be found at or near certain spots. These are indicated in the following diagrams, in Landois & Stirling's *Text Book of Human Physiology*, 3rd Edition, viz.:—Figs. 418, 419, 420, 421, 430, 431, which see.

as Bunsen's for hospital work, or large Grenet cells, or of a similar number of groups of smaller cells. Duncan generally uses from 40 to 80 milliampères of current, but since he advises the operator to be guided by the touch as the process proceeds rather than by the amount of current passing, he does not consider the galvanometer of any use except perhaps for sacculated aneurisms, where palpation is more difficult.

The needles should be insulated to within half-an-inch of their point with vulcanite, and both should be thrust into the tumour or aneurism. Although the positive-pole needle, if made of steel, will be attacked by the acids which it sets free, the resulting salts are non-poisonous and the needle can be easily re-sharpened, so that this effect can be neglected. However, unassailable needles of gold or platinum can be used for the positive pole, if so desired.

Mode of Procedure, say for a nævus, cirsoid aneurism, or goitre. The patient, especially if a child, is to be anæsthetised. The skin over and round the nævus is first cleansed and purified. The needles, unattached to the battery as yet, are then thrust through the skin an inch or two from the nævus, and are pushed subcutaneously into its substance, so that at the first sitting the deeper parts are chiefly attacked. As soon as the needles are placed in position they are connected with the battery, and the process begins. Soon a soft coagulum and crepitation from bubbles of hydrogen gas are perceptible round the negative-pole needle, while a firm hard coagulum is felt to form more slowly round the positive-pole needle. The latter is allowed to remain for the most part in one place, while the negative needle is moved from place to place as the desired effect is produced in each. During these subcutaneous alterations in position, the non-insulated part of the needle must not be allowed to reach the aperture in the skin. An entire coagulation to about the size of a walnut is sufficient for any single sitting. Care should be taken to prevent the cauterising effect from penetrating the skin to the surface. From twenty to thirty minutes is sufficient for one sitting. To obviate bleeding from the needle-punctures, the current should be maintained while they are being slowly withdrawn, so that a coagulum may block their track. Either needle, as soon as its non-insulated part reaches the skin, should be entirely withdrawn, and its aperture at once covered with collodion and wool. The other needle having been withdrawn and its aperture similarly dealt with, the whole of the surface of the part electrolysed should be covered with cotton wool and collodion, and be left alone for a fortnight or three weeks.

For the *Galvano-Cautery platinum wire point or loop*, a battery like that for electrolysis is required. Platinum is selected because it can be heated and cooled again any number of times without becoming oxidised, and because its fusing-point is so high. A current too strong to pass easily is sent through the wire, and heats it in proportion to the resistance which the wire, in virtue of small cross-section, offers. With either loop or point, a non-conducting handle is supplied, provided with a trigger which

can be pressed with the forefinger so as to turn on or off the current.

For lighting the interior of the bladder or urethra, with the endoscope or urethroscope, small incandescent lamps with carbon filaments are employed. The battery recommended by Fenwick * for the purpose "is a 6-cell chromi-sulphuric plunge battery," fitted with a rheostat, which he considers indispensable.

CHAPTER XXI.

JOINT-FIXATION AND FIXED APPARATUS.

Contents.—Remedial effects of absolute Rest—Local Sources of Irritation obviated by Rest—General principles of Treatment by Fixation and Extension—(**A.**) **Treatment of Special Joints**:—(1) The Hip-joint—(2) Knee-joint—(3) Ankle- and Tarsal-joints—(4) Shoulder—(5) Elbow-joint.

Remedial Effects of Absolute Rest. — In certain chronic diseases of the joints—of the type known as strumous or tubercular—the appropriate treatment in the early stage seems chiefly to be prolonged rest. The tubercle bacillus, though associated with, and probably the cause of, these chronic inflammations, may often be destroyed by the tissues under the conditions of improvement of the patient's general health, rest to the affected part, and possibly also compression and counter-irritation. The rest, to be efficient, must be complete and prolonged for weeks, months, or even years—so long, in fact, as signs of disease continue, and for weeks after they have disappeared. Although in most of our General Hospitals, patients suffering from these chronic joint-diseases may not be retained during the whole period necessary for their treatment, still the time allowed is often sufficient for improvement to begin, after the careful application of the immobilising apparatus which is necessary to complete the cure at home.

Local Sources of Irritation obviated by Rest—The local sources of irritation to an inflamed joint which are obviated by ensuring its perfect rest, are:—

(1) *Voluntary Movements.*—These cause friction of the synovial and cartilaginous surfaces within, and of the fascia and tendons around the joint, besides compression of the joint-surfaces by the necessary muscular action.

(2) *Muscular Spasm.*—This indeed limits movement, and fixes the joint in the position of greatest ease; but continuous muscular

* "The Electric Illumination of the Bladder and Urethra," 1888, which see for further particulars.

action is involved, and helps to cause rapid muscular wasting, and continuous compression of joint-surfaces.

(3) *Transmission of Body-weight* (in spine and lower limb), which, besides involving compression of articular surfaces and of bones, necessitates, reflexly, some action of surrounding muscles, however rigidly the joint may seem to be steadied.

Joint rest is obtained by (*a.*) *Absolute fixation*, which not only obviates the first, but also the second source of irritation, for when a joint is steadied in its position of greatest ease without the muscles, they, being no longer needed, relax. As a result, joint-compression is relieved, and so inflammation tends to subside, after which a return to the natural position of the joint is soon possible.

(*b.*) *Extension at first in the line of the deformity* is often of great service in acute cases (*Marsh*).

Extension without fixation, and extension tending at once to reduce a deformity in acute cases, are equally erroneous means of treatment, although the former has had strong advocates in America.

To prevent the evils attendant on bearing weight, the patient must either be kept in bed, or be supplied with an immobilising apparatus, which transmits the body-weight otherwise than through the affected joint. The latter method is preferable in the less advanced chronic cases, since it allows the patient to enjoy some open-air exercise; the former is necessary in acute or in severe chronic cases.

It is well to note that when a joint has to be kept absolutely quiet, other joints must also be fixed whose muscles either pass over the affected one, or are in co-ordination with its movements. Thus, in bad cases, the knee should be fixed with the hip, the ankle with the knee, and the elbow and hand with the shoulder.

A. Treatment of Special Joints.

(1) **The Hip-joint**—(*a.*) *By Thomas's Hip-splint.*—The hip may be fixed by Thomas's hip-splint in all cases where fixation is needed, whether the patient be going about, or be confined to bed. The splint may be applied to the hip at any angle, and this may be altered as required.

One great advantage claimed for this splint by its inventor is, that surgeons at a distance from large centres can with its aid treat their patients at home "with no more mechanical assistance than can be rendered by the village blacksmith and saddler, and the poorer class of sufferers will, at a small cost, be assisted as effectually as the wealthier classes."—*Thomas.*

The following description* will serve to explain the apparatus and its mode of application:—

The Splint consists of an upright bar or stem of flat malleable iron moulded to the body, and furnished with three transverse pieces or crescent "wings," to grasp respectively the chest, the

* Taken partly from Thomas's own book and from conversations with himself, partly from an article on the uses and application of the splint by Jones, in the *British Medical Journal* for Oct. 1, 1887.

thigh, and the knee (Figs. 142 and 143). The upright "should extend from the lower angle of the shoulder-blade, in a perpendicular line downwards over the lumbar region, across the pelvis slightly external, but close to the posterior superior spinous process of the ilium, and the prominence of the buttock, along the course of the sciatic nerve to a point slightly internal to the centre of the extremity of the calf of the leg."—*Thomas.*

Unless where there is marked deformity, the first moulding of the

Fig. 142.—Thomas's Hip-joint Splint applied from the front (*after Thomas*).

Fig. 143.—Thomas's Hip-joint Splint applied from behind (*after Thomas*).

upright is to be made from the sound side; and for this purpose the patient is made to stand upright, the affected limb being raised by supports until the pelvis is horizontal.

Since Thomas first described his splint, he has simplified its shape. For ordinary *subacute and chronic cases* the trunk and lower-limb portions of the upright bar are each quite straight and parallel to one another, only not on the same plane. At the level of the buttock the bar is bent forwards at an angle of about 145° for

2 or 3 inches before being brought back to its former direction. Thus the plane of the lower part will be about 1 inch or 1½ inch in front of that of the upper part (Fig. 144). For acute cases with

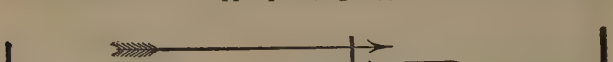


Fig. 144.—Diagram of Thomas's Hip Splint, side view (*after Thomas*). N.B.—The second bend beyond the arrow's point has now been given up.

distinct angular deformity, the upper and lower portions of the splint must be kept at an angle so as to fit the patient's abnormal position. As the acute stage subsides, the splint may be gradually straightened.

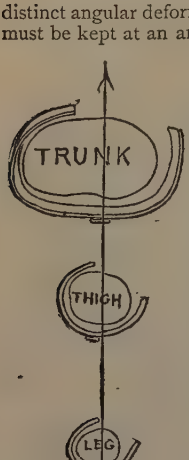


Fig. 145.—Sections of trunk, left thigh and leg—seen from below—to show the application of the cross-pieces of Thomas's Hip Splint (*after Thomas*).

The cross-pieces are made of lighter and therefore more pliable iron than the upright.

Position of Cross-pieces.—The top and bottom ones are in all cases fixed to the two extremities of the upright bar, but the position of the intermediate one varies. When the splint is meant for a patient confined to bed, the intermediate cross-piece should grasp the patient's thigh just below the groin, and should be fixed to the upright about 1½ inch below its mid point. When the patient is allowed to get about, wearing the splint, the intermediate cross-piece is shifted down to about 6 inches from the lower end.

Length of Cross-pieces.—Each cross-piece should be long enough to embrace more than two-thirds of the patient's trunk, thigh, and leg respectively. In practice, Thomas recommends the top cross-piece to be 2 inches less than the full length of the vertical bar, the mid cross-piece to be about 1½ inch less than half the length of the vertical bar, and the bottom cross-piece to be two-thirds of the length of the mid cross-piece.

Mode of Attachment of the Cross-pieces.—Each is riveted to the upright bar, not however at the middle point of each, but at a point nearer to the affected side of the patient, so that the shorter part is towards the diseased side, and *vice versâ*. Thus, Thomas says that the highest cross-piece is to be fixed at the distance of "one-third of its length from the end next to the diseased side." Similarly, the longer end of the middle and lowest cross-piece is also towards the sound side (the left if the right hip is affected, and

vice versâ). When the upper cross-piece is in position, the end corresponding to the sound side comes to the middle line, and the space between the two ends looks obliquely towards the diseased side. Thus, the half of the trunk on the sound side is completely embraced, while that on the affected side is only partially so. Similarly with the lower cross-pieces (Fig. 145).

In *adapting* the splint after its application, a rotatory tendency to any particular side is to be met by opening out the portions of the cross-pieces on the same side, and bending in those on the opposite side, *i.e.*, if there is rotation towards the right, relax the right parts and tighten in the left parts of the cross-pieces. A bandage on the leg and thigh, applied in a direction contrary to that of the rotation, is also recommended for keeping the splint in its place.

Where the affected thigh is much abducted, the long portion (*i.e.*, that on the sound side) of the body cross-piece is to be bent downwards, so as to grasp the trunk at a lower level than usual.

Sometimes children whose condition requires rest in bed, try to get up and walk, when they are not being watched. To prevent this, Thomas fixes on his "nurse," consisting of a piece of iron screwed on to the lower end of the upright, so as to project below the foot and make walking impossible.

When the more acute symptoms have subsided, and the patient is deemed well enough to be out of bed, the boot on the sound side is raised on a patten, and crutches are provided. The affected leg thus hangs, and extends the hip-joint by its weight. Owing to the artificial rigidity of the hip-joint, the patient cannot easily sit, and prefers either to stand or to lie.

Fig. 146. Wrench (*after Thomas*).

Where a patient suffers from double disease, or where there is marked deformity, a double splint is recommended. The distance between the two uprights will then be 1 inch more than the interval between the two posterior superior spines. A cross-bar joining the two uprights, just above the lowest cross-pieces, will add much to the strength of the double splint. This cannot, however, be easily applied when the two hip-joints are at markedly different angles.

Thomas urges surgeons to learn how to mould the splints to fit the patient, and figures wrenches made by the Lowel Wrench Company, Manchester, which he uses for the purpose (Fig. 146).

The surgeon, when he has seen that the blacksmith has rightly made the general proportions of the splint, sends it to the saddler to be padded with a single layer of boiler-felt (No. 1 thickness), and covered with basil leather.

The ends of the body-crescent are to be united by a strap fixed to one side, and buckling or buttoning on to the other. A brace

over the shoulder of the sound side supports the splint. This brace and the secondary straps to steady it are illustrated in the diagrams (see Figs. 142, 143).

For his poorer patients Thomas uses a simpler plan. Each end of the uppermost cross-piece terminates in a hole about half an inch in diameter. The middle of a piece of bandage is passed below the upper cross-piece, where it is attached behind to the upright bar. The ends of the bandage, after having been twisted together for a short distance above the splint, are brought over the patient's shoulders, and are passed through the holes in the upper cross-piece before being tied together. Thus the bandage fulfils the double purpose of keeping the splint up, and fixing together the ends of the cross-piece.

The thigh and leg may be either bandaged to the corresponding part of the splint, or be fixed there with shields similar to those described for the knee-splint.

The thickness of the iron used is indicated by Jones as follows:—

For an adult of about 6 ft. in height, the upright should measure	$1\frac{1}{2}$ by $\frac{1}{4}$ in.
For an adult about 5 ft. 6 in.,	$1\frac{1}{8}$ by $\frac{1}{4}$,,
For a youth or woman,	$1\frac{1}{8}$ by $\frac{3}{16}$,,
For a boy aged 10,	$\frac{3}{4}$ by $\frac{3}{16}$,,
For a child aged 5,	$\frac{1}{2}$ by $\frac{1}{8}$,,
For an infant aged 2,	$\frac{1}{2}$ by $\frac{1}{8}$,,

According to Thomas, the upright for an adult should be of iron 1 in. by $\frac{1}{4}$ in.; for a child, $\frac{3}{4}$ in. by $\frac{3}{16}$ in. The measurements for the upper crescent are to be $1\frac{1}{2}$ in. by $\frac{1}{8}$ in.; and for the two lower ones, $\frac{3}{4}$ in. by $\frac{1}{8}$ in.; but he makes no distinction between those meant for children and those for adults.

Figs. 142 and 143, after Thomas, illustrate the application of the splint.

(*b.*) *By Extension.*—When it is decided to apply **Extension**, the patient must be kept in bed, lying on a firm mattress. The first thing to do is to see what position the thigh assumes when the patient's pelvis is made to lie even—*i.e.*, when the line joining the two anterior superior spines is at right angles to the axis of the trunk, and when the lumbar region of the spine rests against the bed. Whether this position be one of flexion and adduction of the thigh, flexion and abduction, simple flexion, or without deformity at all, it is the one in the line of which traction is to be *at first* made. *Where there is marked flexion*, the lower limb must be raised either on pillows or on an inclined plane. One objection to the inclined plane is the necessity of extending the knee while the thigh is flexed; but inconvenience from this results only when the flexion is great. *Where abduction is combined with flexion*, the inclined plane lies by the side of the other limb. *Where there is adduction*, the incline plane should be arched to allow the sound limb to pass under it. Should the patient be restless, a long splint may be applied to the *sound* side. The plan of raising the affected limb on

pillows is simple and often effective, but may fail to ensure sufficient steadiness.

Having made provision for supporting the leg, the surgeon must next adjust weight and pulley at the proper level. After the foot of the bed has been raised (on blocks, &c.) to allow the weight of the body to act as a counter-extending force, the pulley must be fixed. For this purpose an apparatus may either be attached to the bed, or be independent and stand separate. In either case it must be movable—not only up and down, but also laterally, as may be required.

(*a.*) In the Royal Infirmary, Edinburgh, an apparatus, easily applied to the bars of a crib, is used in some wards. It is said to have been introduced from Liverpool (Fig. 147).

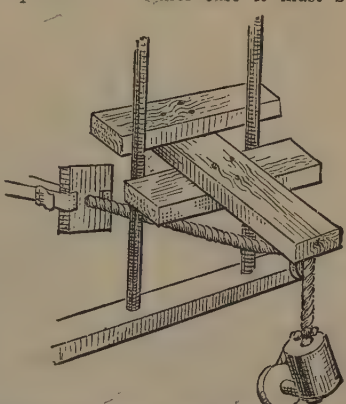


Fig. 147.—Attachment for weight and pulley.

(*b.*) In others, an upright bearing the pulley is lashed to the bed, or fits into a scaffold which hooks on to the end of the bed. The scaffold can be moved laterally, and the upright raised as desired by adjusting iron pins (Fig. 148).

(*c.*) Marsh figures in his work on Diseases of Joints a simple stand, with a projecting arm, which can be moved up and down as required. To the projecting arm the pulley for the extending cord is fixed.

Other apparatus, probably equally simple and effective, might easily be devised.

(*d.*) Where the child is laid in a crib with long uprights, the pulley may be made of an empty cotton reel, running on a pencil or penholder, made fast to two bars at the proper level, or suspended from above.

Materials for Extension.—For applying extension we require strong moleskin plaster, broad tape, scissors, stout needle and thread, cotton bandages, and a piece of wood as long as the breadth between the malleoli, or a square of wood of these dimensions with a hole in the middle, and having short straps and buckles nailed to any two of the opposite sides (see Fig. 147). Bricks or wooden blocks 3 or 4 inches high, on which to raise the bed, are also needed, and a weight, either in the form of a bag to be filled with sand or shot, or in that of ½ lb.- or 1 lb.-masses of lead or iron, bored in the centre for convenience in taking off or putting on. The plaster strips (one for each side of the leg) must be long enough

to extend from beyond the foot to the middle of the thigh, and be as broad above as about half the circumference of the limb. They

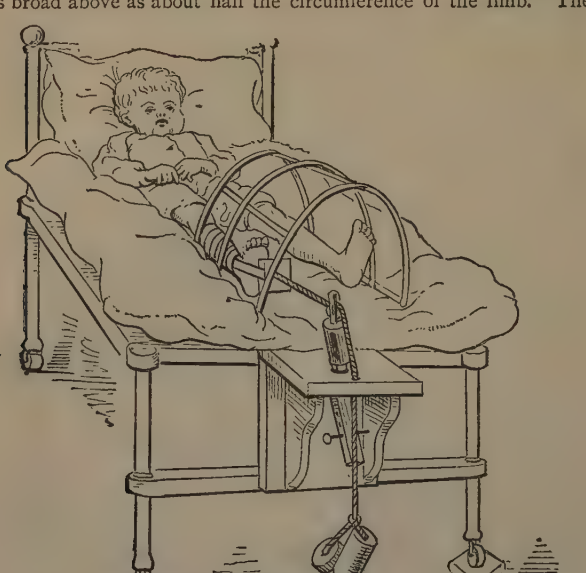


Fig. 148.—Extension with weight and pulley applied.

may be cut from one rectangular piece (as shown in Fig. 149), or each may be rectangular, with the edges of the lower part folded in, to give greater security to the tapes which are sewn to it (Fig. 150).

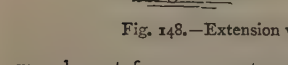


Fig. 149.—Two-plastered cut from rectangular piece.

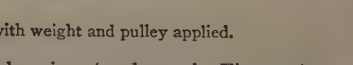


Fig. 150.—Single plaster from rectangular piece.

Snips at the margin permit more accurate fitting of the plaster to the limb.

Mode of applying Extension.—When everything is ready, begin by

shaving off hairs. Then with a cotton bandage make a few turns round the ankle, to protect the malleoli. Next heat the plaster-strips, apply them evenly to the limb, making additional snips where necessary, and cover the whole with the roller-bandage. At the upper end, turn down a few inches of the plaster so that the sticky side presents to the bandage; this helps to give greater security.

Another method of avoiding troubles with hairs is to carry up the leg a layer of bandage, to which, and not to the skin, the plaster is applied, the whole being fixed by a second layer of bandage. When the plaster is secure, fasten the tapes to the buckles which are fixed to the square of wood below. Next pass a strong cord through the hole in the wood, and knot it to prevent its slipping out. The other end goes over the pulley, and carries the weight.* Place the limb now in the desired position, supporting it with pillows, or on an inclined plane; adjust the pulley, and attach the weight. The amount of weight for a child of five or six years of age should be 3 or 4 lbs., and more in proportion for an adult. It is best, in all cases, to begin with a light weight and gradually increase it, till the muscles are relaxed and the patient feels comfortable. The plaster is carried above the knee, to prevent the ligaments of the knee from being relaxed by the continuous extension.

As a general rule, children in hospitals lie very quietly and make no efforts to get up. Should they be restless, besides a long splint applied to the *sound* limb, the following chest-band may be used:—"The chest-band consists of a piece of webbing, passing across the front of the chest and ending in two loops, through which the two arms are passed, and through which is threaded another piece of stout webbing, which runs transversely across the surface of the bed, under the child's shoulders, and is fastened at its two ends to the sides of the bedstead" (*Marsh*).

In some cases, where distortion is not an obstacle, fixity of the hip-joint may be attained by the single or by the double long splint, extension being produced either by the perinæal band and foot-extension, or by the weight and pulley.

(2) **The Knee-Joint.**—The principles of treatment which have been discussed for the hip-joint apply equally to the knee, where they are more easily carried out, owing to the greater accessibility of the joint. When left to itself in a state of strumous disease, wherever this has begun, the knee-joint tends to become more and more flexed, till in some cases, it can flex no more. The lateral and crucial ligaments are at first softened so as to allow the tibia to be gradually dislocated backwards and rotated outwards by the flexor tendons, but, if the disease subsides, they contract and oppose the return of the bone to its old position. The primary cause of the deformity is therefore muscular. On the other hand, the deformity which occurs in acute synovitis, depends mainly on mechanical dis-

* The object of the wood is to keep the tapes from pressing unduly on the malleoli. A simpler way than the above is to unite the two tapes below the foot to the ends of a piece of stick, and extend by fixing to the centre of the stick a cord which carries the weight.

tension of the capsule by effused fluid. The joint assumes the position of greatest capacity of the membrane, which is that of slight flexion.

Although anchylosis of a joint is always a disadvantage, there is in every joint a position in which anchylosis is least disadvantageous, and there are some joints in which anchylosis is less of an evil than it is in others. Those which can, so to speak, best permit of anchylosis are the Knee and—owing to the great mobility of the scapula—the Shoulder. The knee, when anchylosed, should be slightly flexed; if quite straight, it is apt to be in the way, while not more useful; if much bent, it is a useless encumbrance. Hence, and also because slight flexion is the natural position of repose of all joints, we should fix diseased knee-joints in this position, or gradually bring them back to it, if they have already left it.

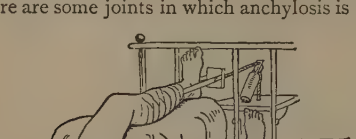


Fig. 151.—Extension applied to a flexed knee.

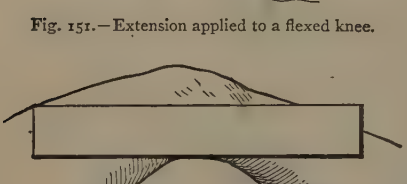


Fig. 152.—Straight pasteboard splint for knee.

Reduction of too great Flexion—(*a.*) *By Fixation and Extension.*—In reducing too great flexion of the knee, the same means must be taken as were indicated for the hip. Whether fixation or extension be employed, the deformity in acute cases must be respected in the first instance, and no effort made to overcome it until irritation and muscular spasm have subsided. Hence, instead of extending the limb by weight and pulley towards the bottom of the bed, the surgeon should first support the thigh, so that the downward line of traction on the tibia is in the line of the deformity (Fig. 151).

By degrees, as irritation subsides, the line of traction may be more and more altered until it comes to correspond with the axis of the thigh (*Marsh*).

(*b.*) *By Lateral Splints.*—Where there is no great deformity, some surgeons prefer well-padded lateral poroplastic, pasteboard or leather splints. In order to limit movement it is not always necessary to shape the splints quite accurately—a broad, straight strip down each side is often enough, if well bandaged (Fig. 152); but if the greatest rigidity is needed, the side-splints must be cut to the shape of the bent knee.

A simple way is to take a doubled piece of paper, long enough to go 7 or 8 inches above and below the knee, and an inch or two wider than half the circumference of the thigh. Place the limb

in the desired position; lay the edge of the upper half of the paper along the line of the thigh, and cut the lower half of the paper to correspond with the line of the leg. This gives the anterior edge of the splint; the posterior edge can easily be trimmed nearly parallel to it at a distance equal to half the circumference of the limb (Fig. 153). When the halves are opened out, the pattern for each side will be ready.

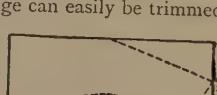


Fig. 153.—Pattern for lateral pasteboard splints.

After the millboards have been cut to the required size, each half must be softened by pouring boiling water first on one side and then on the other. Tear the edges thin to make them lie evenly, and make slight transverse tears at the bend of the knee. Then, having padded the limb well, bandage on the splint, and let it dry in position, or, having removed it carefully while in the soft state, dry it at the fire. *Poroplastic Felt*, when used, requires to be softened before the fire or over the gas before being applied. *Undressed Cowhide* may also be used. It has to be softened by soaking in cold water before being moulded to the part.

(*c.*) *By a Posterior Splint* of metal, Gooch, or straight wood, reaching from the top of the thigh to the calf of the leg, and especially well padded behind the knee.

(*d.*) *By Thomas's Knee-splint.*—For all cases of strumous knee-joint disease, unless where there is very marked flexion, there is no better splint than Thomas's Knee-splint. The objects of its inventor are to ensure immobility without external compression of the joint, and in suitable cases to permit of out-of-doors locomotion for the patient without allowing the joint to bear weight. The mechanism of the splint is extremely simple (Fig. 154). Two light iron bars pass up the sides of the leg. Above they are fixed to a padded iron ring (Fig. 155), on which the patient sits when erect; and below they end in an ovoid ring (Fig. 156, *b*), which rests on the ground beyond the foot.* A piece of leather between the bars supports the leg and thigh behind. The limb, after being placed in position, can be easily fastened to the splint by bandages above and below the knee. A patten on the boot of the sound side makes both limbs equal (Fig. 157).

The inventor, intending that this splint also should be made by any blacksmith and saddler, has given minute directions for its construction:—

* Recently Thomas has introduced for less severe forms of synovial joint disease, a "caliper" ending to the knee-splint, instead of the ovoid ring. In this arrangement, the lower ends of the vertical bars are bent abruptly in towards one another just below the patient's heel, and are cut off short so that they may fit into a piece of brass tubing, which is sufficiently long to make the vertical bars clear the malleoli. When the patient is well enough to walk, this tube is let into the heel of the boot, by boring a hole for it in children, but in adults by cutting out a slot for it so as to allow of some rotation in walking. The heel part of the "upper" leather must at the same time be cut down the middle and laterally at its attachment to the heel, otherwise the patient's heel will be unduly pressed upon.

The upper ring is of malleable iron $\frac{3}{8}$ in. in thickness, varying according to the age and weight of the patient. It is "nearly ovoid" in shape—*i.e.*, broader at the inside than at the outside. Its

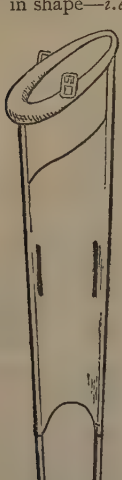


Fig. 154.—Thomas's Knee-splint for left side, front view (*after Thomas*).

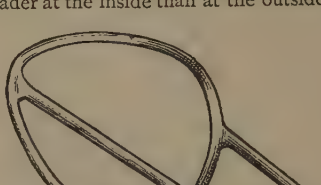


Fig. 155.—Perinæal ring for a Thomas's Knee-splint (left side), seen from above.

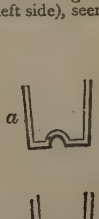


Fig. 156.—(*a*) Staple ending. (*b*) Ring ending for Thomas's Knee-splint (*after Thomas*).

curve is flatter in front than behind. The outer side stem is attached at about the middle of the outer part of the ring, while the inner stem is fixed somewhat in front of the middle of the inside (Fig. 155). The upper ring is set by the blacksmith at an angle of 130° with the inner stem (Fig. 158).

The padding is made thicker on the inside than on the outside of the ring, but the angle has been fixed upon to allow of this.

When pressure is to be taken off the affected knee as the patient walks, the lateral stems should extend far enough below the foot to raise the toes, even when extended an inch from the ground. A patten, curved below to facilitate walking, must be fixed on to the sole of the boot of the sound side.

Fixing the Splint in Position.—The leather apron between the vertical bars for the limb to rest on, and the method of fixing the limb to the splint with a bandage, have latterly been given up by Thomas. He now uses between the bars two pieces of leather,

each about 2½ inches wide. One is placed so as to support the back of the calf, while the other comes behind the lower end of the thigh. After the splint has been placed in position with the ring encircling

Fig. 157.—Thomas's Knee-splint applied (*after Thomas*).

Fig. 158.

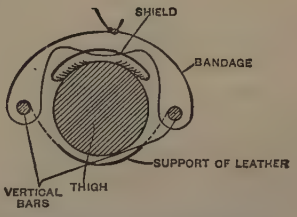


Fig. 159.—Diagram to illustrate mode of fixing Thigh to Knee-splint.

the thigh at the groin, the limb is fixed to it at two points only—*i.e.*, just above and just below the knee. A well-padded shield of block tin or zinc is laid over the limb at these points, and is then fastened backwards by a loop of bandage, which passes round the vertical bars on each side. The shield is perforated in two places to allow the bandage to pass through it (Fig. 159).

The splint is prevented from slipping down by a strap and buckle over the opposite shoulder.

Materials for covering and padding are the same for the knee as for the hip-splint—*i.e.*, basil leather for covering the splint and for supporting the leg and thigh, and No. 1 boiler-felt for padding with.

When there is unusually great swelling of the knee, the lateral bars may require to be bent outwards, so that they may not press

upon the swelling. When the thigh ring cannot pass the knee, owing to its being swollen, the ring may be cut or sawn through, opened out, and, after it has been passed over the knee, bent in again with a wrench.

Thomas's Knee-splint has been used for fractures and other conditions besides those of knee-joint disease. When extension is required, it can be applied to the foot by means of the lower staple (Fig. 156, *A*).

(3) **The Ankle- and Tarsal-joints.**—For the ankle- or tarsal-joints lateral pasteboard or leather splints will ensure fixity and compression. The foot must not, however, be put to the ground.

(*a.*) In many cases *Thomas's Knee-splint*, supplied with a foot-piece to steady the ankle, will be found useful. He uses it constantly for this purpose.

(*b.*) *Gamgee's method* of cutting lateral pasteboard splints for the ankle, is both simple and economical of material. It may be described as follows:—Take a rectangular piece of mill-board,* which measures in length from the knee (above or below as required) to the middle of the sole of the heel, and half the circumference of the foot at the instep, *more;* and in breadth is equal to the circumference of the leg at the ankle. Along the middle of this, lay a line which extends to within half the circumference of the foot from the ends; and from the extremities of this line, draw others at right angles to it, each running in an opposite direction to the other. The pattern of the two splints will now be complete (see Fig. 160). With a penknife make cuts in the board along the lines, and, by bending, break off the two pieces, which can be softened and applied in the usual way.

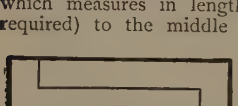


Fig. 160.—Pattern for pasteboard splints for foot.

(*c.*) When the foot has to be fixed while room is left for *dressings* at the ankle, a wire-splint should be made to fit the calf of the leg, and support the bones of the leg well. To this a foot-piece is attached, but bulging laterally or posteriorly to give room for dressings at the ankle. The foot is fixed to the foot-piece by figure-of-eight turns passing under the heel, which has been previously well-padded. The leg can be easily secured to the leg-piece by turns of a bandage.

(*d.*) *In Esmarch's iron* "*stirrup-splint*," the leg-part fits on to the front of the leg, and the connecting rod of strong iron arches over the dorsum of the foot to the sole-piece (Fig. 161).

(*e.*) *Volkman's anterior wooden splint* is similar in principle (Fig. 162). Macintyre's splint (see Fig. 120) may also be used for some cases.

(4) **The Shoulder-joint** can only be completely controlled when the whole arm with the hand is fixed. The simplest way is to put a good layer of cotton-wool next the skin of the trunk, and bandage

* Gamgee advised the use of that which had not been finally pressed.

the arm to the side—the hand being placed on the opposite breast. When additional steadiness is required, a shoulder-cap of paste-

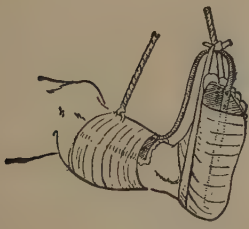


Fig. 161.—Esmarch's stirrup-Splint.

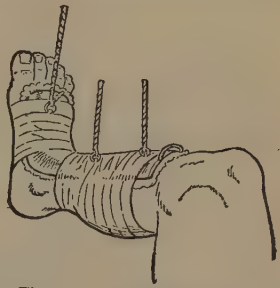


Fig. 162.—Volkman's anterior wooden Splint.

board or poroplastic felt must be fitted to the shoulder, and bandaged in position. It must be shaped as shown in the diagram (Fig. 92).

(5) **The Elbow-joint.**—When absolute rest is required, the hand and fingers should be fixed as well as the elbow, for not only is the whole elbow-joint more or less involved in pronation and supination, but since the flexors and extensors of the fingers arise near the elbow-joint and pass across it, their contraction must involve some stimulation of the parts near the joint, as well as excite it by movement.

A rectangular splint is the form most usually chosen. It may be of wood, of which a set of different sizes may be kept ready with advantage. Many, however, prefer to cut the splints, as wanted, from paste-board or poroplastic felt. The following is a simple method of doing this :—

Cut out a square of paper, with the sides equal to the distance from the acromion process to the point of the elbow (Fig. 163).

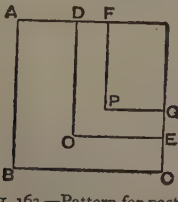


Fig. 163.—Pattern for paste-board Arm-splint.

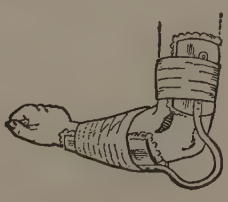


Fig. 164.—Jones's Elbow-splint.

Measure off A D, equal to half the circumference of the upper-arm, and D F, C E, and E G equal to half the circumference of the wrist.

Draw D O, E O; F P, G P parallel to the sides, and cut out the pieces so marked out. These splints have next to be fitted to the arm. The larger one fits on the outside of the arm and shoulder, A D being at the acromion. The inner splint is reversed, G E being in the axilla, and D F on the fore-arm. If these paper splints seem suitable, copies of them are to be cut in pasteboard or poroplastic felt, and after having been softened applied to the limb. When, along with fixation, the elbow is to be left free for the application of dressings, some form of bridge splint must be used, such as that advocated by Robert Jones of Liverpool (Fig. 164).

CHAPTER XXII.

JOINT-FIXATION AND FIXED APPARATUS—*Continued.*

Contents.—**B. The Spinal Column**—General Treatment—Caution!—Artificial Supports in Spinal Disease—(1) Methods for ensuring Rigidity and Support to the Spine—The Plaster-jacket—(*a.*) Objections to its use considered—(*b.*) Materials for making the Jacket—(*c.*) Methods of Application—(2) Methods of ensuring Support in High Dorsal and Cervical Caries—The "Jury-mast"—Pneumatic and other Special Collars, &c.

B. The Spinal Column.

In acute cases, especially where accompanied with considerable pain, patients suffering from disease of the spinal column should be treated in bed, as this is the only way of giving complete rest to the spine. Extension by weight and pulley is often of service. Professor Chiene advises that—

When *the lumbar region* is affected, the foot of the bed should be raised, and extension plasters applied to both legs.

When the mischief is in *the cervical region*, extension should be applied to the patient's head, while the same end of the bed is raised to allow the weight of the body to act as a counter-extending force. The patient's head in this case must rest on a low pillow, and be steadied laterally by sand bags.

When *the mid-dorsal region* is affected, the bed may be kept horizontal, and extension applied to the patient's legs and head.

Extension-plasters may be fixed to the legs in the usual way; to the head, the apparatus may be fixed to a cap fastened round the forehead and below the occiput, and, if need be, secured below the chin.

Fleming of Glasgow recommends an apparatus patented by Hilliard, Instrument-maker, for carrying out spinal extension. Attachment to the head is taken from a strap passing below the

occiput and above the eyebrows. From this an elastic cord passes to the head of the bed. Instead of drawing on the legs, Mr. Hilliard extends downwards from the pelvis—*i.e.*, from the back of a belt fixed above the crests of the ilium. This method allows of more turning in bed than Professor Chiene's, but it is doubtful if the increased power of movement is an advantage.

Caution!—When the disease involves *the first two cervical vertebræ* the risk is greater, because of the importance of the corresponding part of the spinal cord, should it become involved; and because of the probability of the ligaments which keep the odontoid process in position becoming softened—in which case, at any moment, instant death may be caused by the compression of the cord against the odontoid process, as the head is dislocated forwards. It is generally considered safe, when disease in this part of the spinal column has been diagnosed, to recommend at first *rest* in the horizontal (supine) position, the head being steadied as above, whether extension also be deemed necessary or not. Afterwards, some efficient head- and neck-splint, such as will be presently described, should be used.

Benefit of Artificial Supports for Spinal Disease.—It is well to recognise that there are four possible ways in which such supports may act beneficially.

(1) By preventing movements. This seems to be one of the most important, because it must necessarily involve

(2) Prevention of further displacement, and so the saving of the affected parts from continuously followed-up pressure. It is moreover possible

(3) to relieve the anterior parts of the vertebral bodies from pressure by bracing back the spine, and causing the weight to be transmitted through the articular processes and through the posterior parts of the bodies (*Walsham*).

(4) Relieving the affected part from pressure altogether. In the dorsal and lumbar regions this has been attempted by trying to transmit the weight from the axilla to the pelvis by means of crutches. In the neck also Sayre has attempted the same thing by his "Jury-mast" (Figs. 169 and 170), which takes its fixed point on the thoracic plaster-jacket, and then arching over the head partly suspends it. Fleming's india-rubber air-bags (Fig. 171) also partly transmit the weight of the head to the shoulders, without its passing through the spine. Still, the value of both of such forms of apparatus is probably as much from their steadying power as from the support they give. In the cervical, and still more in the regions of the spinal column below it, any apparatus which really took all the weight off the vertebræ would be unbearable.

1. Methods for ensuring Rigidity and Support to the Spine Plaster Jackets.—Most surgeons agree that when the patient is able to go about, rigidity and support of the affected part of the spine are what are most needed.

The kinds of rigid support most easily applied are those made of *plaster of Paris*. Many different modifications of Sayre's original plan have been suggested. We may, however, group them all together as either vertical (Sayre's), or as the horizontal methods in

which the supposed dangers of suspension are obviated by applying the splint while the patient is in the recumbent position. Of the latter we shall only describe Furneaux Jordan's and Davy's methods.

(*a.*) *Answers to Objections urged against Plaster Jackets.*—Before taking up any method, however, it may be well to consider some objections which have been urged against the use of plaster jackets :—

(1) *Confinement of Perspiration.*—Sayre, however, has shown that plaster jackets are quite as porous as the material of any other efficient jacket.

(2) *Liability,* in certain patients, *for the accumulation of vermin.* This may be obviated by the thorough cleansing of the patient's skin before the splint is applied, by steeping the semet in a saturated solution of boracic acid, and letting it dry before applying the plaster. Provision may also be made for changing the semet without disturbing the jacket, if two, lightly tacked together, instead of one, are put on at first. When a change is needed, the clean semet is fastened to the inner of the two, and on the latter being withdrawn the clean one is pulled into its place. The outer semet is held in position by the plaster.

(3) *Interference with Respiration.*—In so far as there is lessened thoracic and increased abdominal respiration, this is an advantage for the spinal column. Respiration, as a whole, does not seem to be notably affected in well-applied jackets.

(4) *Tendency to produce ulceration* by pressure on the prominences. This is due to insufficient padding. Where there are unopened abscesses the jacket should only be applied if infrequent aspiration is to be employed, as antiseptic dressings cannot be efficiently applied through the fenestra, which Sayre recommends for the purpose. Where a sinus already exists, however, unless the quantity of discharge is very great, a jacket with an opening may be applied with advantage.

(*b.*) *Material of the Plaster Jacket.*—The material with which the plaster is to be incorporated, whether as bandage or in layers, is "some loosely-woven material, such as cross-barred muslin, mosquito-netting, or crinoline." (Some surgeons think that the stiffening should be first removed from the material, by soaking it in hot water.)

For bandages, tear it into strips 3 yards long and from 2½ to 3 inches wide. To work in the plaster, take a quantity of freshly-baked plaster of Paris in a bowl ; spread a newspaper over any flat table or board ; now lay one end of the bandage on the table, and having sprinkled plaster freely over it, rub it in with the hand ; roll up *loosely* with the fingers the part of the bandage thus treated, and proceed with a new part, which is to be in turn rolled up. Repeat this until the bandage is finished. Several may be done at the same time. Unless the roll is quite loose, the water will not enter freely into it when it comes to be soaked for immediate use.

(*c.*) *Sayre's Method of Applying the Plaster Jacket—Preparation of the Patient.*—Any markedly prominent spinous process is to be well padded round about with well stuffed glove-fingers (*Sayre*), or pads of lint or absorbent wool. In thin subjects, the iliac crests also may be protected by several folds of cloth put on until the plaster has set ; when removed, they relieve from undue pressure. "If the patient be a female, and especially if she be developing at the

time, it will be necessary to apply a pad under the shirt over each breast before the plaster bandage is put on. These pads should be removed just before the plaster sets, and at the same time slight pressure should be made over the sternum for the purpose of indenting the central portion of the plaster jacket, and of thus giving form to the body, and removing pressure from the breasts."—*Sayre.*

(Sayre's "dinner pad," is a folded towel placed temporarily over the abdomen to make room in the jacket for expansion after a meal; it has been found unnecessary by many surgeons.)

The inner semet chosen should consist of thick flannel, fitting closely to the skin without wrinkles, reaching from the axilla to the trochanters; it is supported by tapes over the shoulders, and is fastened below by tapes tied over a perinæal pad. Over this a second semet may be fitted, but still better a piece of woven webbing (procurable from Turnbull & Wilson, Edinburgh), which extends from the axilla to the knees, and is thus long enough to be doubled back over the outside of the jacket when it is finished. The advantage of a double semet has been already pointed out (p. 196).

How to put on the Jacket—The Suspension Apparatus.—When the semet and the padding have been adapted, the patient must be partially suspended while the plaster is being applied. Sayre urges surgeons to notice that the suspension is to be only *partial*—up to the point at which the patient feels comfortable, and no further. This generally means raising the heels slightly off the ground, while the toes touch it (Fig. 165).

The suspending apparatus recommended by him consists of a "curved iron cross-beam, to which is attached an adjustable head-and-chin collar with straps, and also two axillary bands.* To a hook in the centre of the bar is fixed a pulley, the other end of which is secured either to a hook in the ceiling, or to the top of an iron tripod about 10 feet in height."

Fig. 165.—Application of Sayre's Plaster Jacket (*after Sayre*).

When by this or similar means the patient has been carefully suspended, the rolled plaster bandages must be applied as follows:—Each bandage as required is placed end uppermost in a basin containing water enough to cover it. As soon as the air-bells have ceased to rise, the bandage must be taken out, and gently squeezed to remove any superfluous water, it is then "applied round the smallest part of the body, and is carried around and around the trunk downwards

* Dr. J. Taylor advises that these should be made rigid—pieces of curved and well-padded iron tubing would serve the purpose well.

to the crest of the ilium, and a little beyond it, and afterwards from below upward in a spiral direction, until the entire trunk from the pelvis to the axillæ has been encased. The bandage should be placed smoothly around the body, not drawn too tight, and especial care taken not to have any single turn of the bandage tighter than the rest. Each layer of bandage should be rubbed most thoroughly with the hand by an assistant, that the plaster may be closely incorporated in the meshes of the crinoline, and bind together the various bandages which make up the jacket, thus making it much stronger than if attention is not paid to this particular. If you notice any spot which seems weak, or likely to give way, pass the bandage over it, and then fold it back on itself, and do this until you have placed several thicknesses of bandage over this point, being careful to wet all well together, and then pass a turn completely around the trunk to retain any ends which may have a tendency to become detached."—*Sayre.*

As soon as the plaster has sufficiently set, lay the patient down on a sofa, mattress, or air-bed; meanwhile remove the dinner and iliac pads, and press gently in front of each anterior iliac spine to widen the jacket laterally. For a child with a narrow pelvis, Sayre advises to mould a waist to the jacket by pressing it in "at the sides above the ilium, and in front and rear above the pubes."

Should a window be required for dressings, it should be cut while the plaster is still damp. The position of the window may be indicated by a pin left projecting while the bandage is being applied.

Although the plaster *sets* in 10 or 15 minutes, it is not thoroughly *hard* until quite dry—*i.e.*, not for 24 to 36 hours. Unless unavoidable, keep the patient horizontal for this time.

Furneaux Jordan's Laminated Plaster Method, as described by the author in the *British Medical Journal*, July, 1882, is as follows:—

"The surgeon first determines how much of the limb or trunk it is well to cover. A pattern is then cut—one of the layers of checked muslin does very well for this purpose, as it is stiff enough to keep its shape, and is easily marked with a pencil. Afterwards, other pieces of muslin are cut of the same size and shape. Six or seven layers make a good average splint; three or four will do for a child; eight or nine may be needed for a heavy, restless, or delirious patient. The first layer is laid flat on the table, and sprinkled with a layer of good dry powdered plaster, which is smoothed over with a spatula or paper-knife; on this, with its margins corresponding, is placed the next layer of muslin, which in its turn is sprinkled with plaster. The process is repeated until all the layers are in place. The splint is then slowly and carefully folded or rolled up and kept dry, ready to be dipped in water when wanted. The water—let this be well understood—immediately passes through any number of layers of muslin and plaster, thoroughly drenching them both in less than sixty seconds.

"The part to be encased is drawn into position, and held so until the plaster partially sets. If the fingers of the extending hand be in

the way, as when the foot is included in the splint, a temporary sling of webbing or plaster over the instep and heel may be used, which can be drawn out or relaxed afterwards. A flannel bandage, or layer of wadding or jersey, is next applied without traction. The splint is now dipped in hot water (hot for comfort and for more rapid setting) for a minute or so. When taken out, it is very gently squeezed, being still quite sloppy and limp. When the water is pressed out too freely, the sheet will be sandy, friable, and difficult to apply. The splint is then unfolded, and drawn out in a perfectly soft and smooth sheet; it is next put under the ailing part, and simply folded over. The overlapping margins instantly and firmly adhere to each other. Traction should be most carefully avoided; perfect neatness is enough. The layered plaster splint is applied with as much ease, as regards limpness and adjustability, as is a

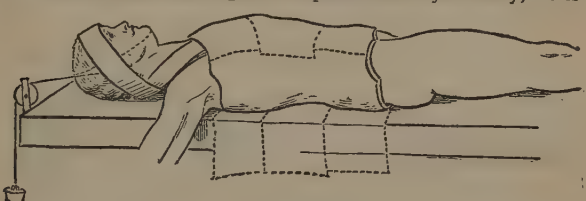


Fig. 166.—Furneaux Jordan's laminated Plaster Splint for the spine (*after F. Jordan*).

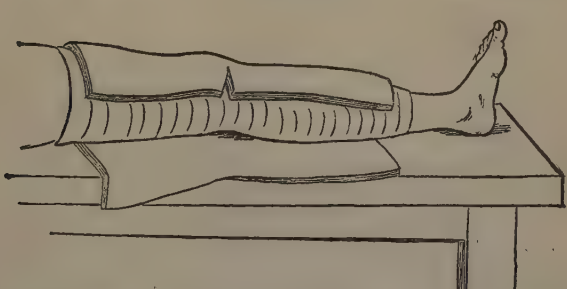


Fig. 167.—Furneaux Jordan's laminated Plaster Splint for the leg and thigh. (*after F. Jordan*).

fomentation; but it is a fomentation which sets, and, with rock-like firmness, lastingly holds the part in any given position.

"In the upper limb, the laminated sheet should be large enough to overlap two or three inches; in the lower limb, the overlapping should extend to three or four inches; in the trunk, to five or six. A pair of strong sharp scissors easily trims the splint while it is still

wet. . . . Windows, scollops, or openings of any kind, do not weaken a splint; and it is better to make them opposite bony prominences, breasts, and other compressed parts, as well as opposite abscesses, wounds, and compound fractures."

This general description will suffice, aided by illustrations after F. Jordan, to explain the application of his method to the spine (lower dorsal, and lumbar regions). The other applications of the same method have been introduced at the same time to prevent the need for repetition afterwards (Figs. 166, 167, and 168). He further states that while he prefers to apply his spinal splint while the patient is recumbent, the method is equally applicable when the patient is suspended vertically, and is more easy to carry out than Sayre's.

Mr. Walker, of Peterborough, invented a similar method, but since it is more complicated, we do not describe it.

(*e.*) *Davy's Method.*—Mr. Davy advocates the application of the Sayre plaster bandage while the patient is slung prone in a hammock

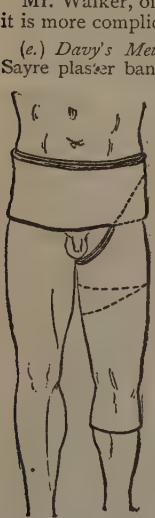


Fig. 168.—Furneaux Jordan's laminated Plaster Splint for the thigh and pelvis (*after F. Jordan*).

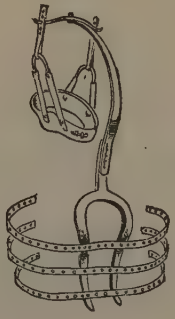


Fig. 169.—Sayre's Jury-mast (*after Sayre*).

Fig. 170.—Jury-mast applied (*after Sayre*).

made of coarse towelling. He uses a soft woollen hand-knitted vest as a semet. The hammock, as broad as the patient's chest from axilla to axilla, is fastened in front to a stout wooden rod, from whose projecting ends the supporting stays are made fast. The other end of the hammock, extending beyond the feet, is gathered into a knot, and fixed to a rope with a pulley.

The patient being laid prone on the hammock is made to grasp the ends of the rod with the hands; the forehead is supported against a band stretched between the two stays. While thus suspended, the patient remains quite comfortable during the application of the plaster bandage, and until the plaster has set. He is then taken down, and the edges of the hammock are trimmed off with scissors.

2. Methods of Support in High Dorsal and Cervical Caries.—As the upper limit of the ordinary jacket is determined by the axilla, it is evident that diseased vertebræ in the upper dorsal and cervical regions must have some other and special means of support. To some of these a brief allusion has already been made; further details are, however, here necessary.

(*a.*) *Sayre's "Jury-mast."*—Sayre describes his "jury-mast" as follows:—"There are some cases of spondylitis in which the cervical or upper dorsal vertebræ, or both together, are involved. In these cases treatment by the plaster jacket alone can do but little, if any, good. It then becomes necessary to treat the disease by the use of an instrument which I call the 'jury-mast' (Fig. 169). This consists of two pieces of malleable iron, bent to fit the curve of the back. To the lower portion are attached three or more strips of tin, long enough to go nearly round the body. These strips are roughened like a nutmeg-grater, by having holes punched out through them in both directions, in order to firmly fasten the strips to the jacket. The tins must be rough on both sides, else the layer of the jacket on the smooth side will not hold the tin, and the jury-mast will slip up and down.

"From two cross-bars at the upper extremity of the curved iron pieces, springs a central steel shaft, carried in a curve over the top of the head, and capable of being elongated at will. To this is attached at its upper extremity a swivel cross-bar with hooks, from which depend straps supporting a head-and-chin collar. This cross-bar must be placed above the curved steel arm, or it will be liable to become detached, owing to the constant traction on the screw by which it is held in place.

"The apparatus is thus applied (Fig. 170):—The patient having been encased in the usual manner in a few thicknesses of plaster-roller, the jury-mast is put on over this, care being taken that the malleable iron strips are bent so as to conform to the surface of the plaster, on each side of the spine, and that the shaft over the head be kept in the same line with the spinous processes. The extremity to which the swivel cross-bar is attached should be over the vertex of the head, so that when the straps are applied the line of traction shall be neither too far forward nor too far back. The perforated tins are carried partially round the body. The apparatus having been thus carefully adjusted, fresh layers of plaster bandage are applied over it in order to hold the instrument firmly in its place, the assistant being careful to rub the bandage into all the inequalities caused by the instrument.

"After the jacket is thoroughly hardened, the chin-piece is to be

applied round the patient's neck, so that it supports the chin and occiput comfortably, and the straps attached to it are hooked on to the cross-bar, the degree of traction made upon them being regulated by the feelings of the patient" (*Orthopædic Surgery*, p. 463).

(*b.*) *Walker & Russell's Modification of the "Jury-mast."*—A modification of this appliance was introduced by Drs. T. Walker, of Peterborough, and Frank Russell. Instead of arching a steel rod over the back of the head to carry the cross-bar, they brought up the sides of the head two prongs of a fork from which to take the points for suspension. The lower part of the fork was fixed indirectly to a plaster jacket.

The following details have been kindly supplied by Dr. Russell:—

The fork is fastened by screws to the chest-piece. The latter is a slightly curved piece of iron, 5 or 6 in. long, ⅞ in. broad, and $\frac{1}{10}$ or $\frac{1}{12}$ in. thick. Lateral pieces of roughened tin give it greater security in the plaster jacket, and projecting from the front of it are two screws, ⅜ in. thick. These, when passed through corresponding slots on the handle of the fork, are fixed there with nuts. The screw should project ⅝ in. beyond the end of the nut.

The fork consists of a flat plate (handle) about 8 in. long, ½ in. broad, and $\frac{1}{10}$ in. thick, ending above in a fork large enough to pass across the patient's throat, and whose prongs, terminating in hooks turned outwards, reach to a point either above or below, but not opposite to the ear. The prongs of the fork are necessarily bent, at first backwards and then upwards. Each of the two slots cut in the handle should be about 1½ in. long, and should be just wide enough to admit the screws without side play. The flat piece of iron "is fixed under the last layer of the jacket, during its application, great care being taken to place it exactly in the median line of the body, and to bring its upper end to within 1½ in. of the top of the sternum." The nuts are removed, and the screws are protected by an envelope of lint while this piece is being fixed to the jacket. *When the plaster is hard*, the slots of the fork handle having been passed through the projecting screws, and the level of the prongs adjusted, the whole is made fast by screwing home the nuts. Straps round the chin and occiput, from the hooks of the prongs, are used to suspend the head.

(*c.*) *Fleming's India-rubber Bags* (Fig. 171).—"The arrangement consists of two or three sets of fusiform india-rubber bags, connected by a narrow flexible but non-elastic material, and having at the free end flaps by which they can be laced together. In each set the bags are internally in communication with each other, and from the lowest depends an india-rubber tube, with a stop-cock, to which the nozzle of an ordinary blower fits. A size suitable to the particular case having been selected, it is, while collapsed, laced rather loosely round the neck.

"On inflation, the lower bag rests upon the root of the neck, the clavicle, and the muscles of the shoulders, while the upper bag moulds itself, along the posterior portion of the jaw, the mastoid process, and the skull, back to the occipital region. The front of the apparatus, where it is laced is, on inflation, rather withdrawn from the neck, so that no pressure on the trachea is produced.

"In practice, I find it best, in the majority of cases, to adjust a piece of poroplastic round the neck like a wide turn-down collar. . . . The apparatus is light, can be worn in the upright, or in the recumbent position, and, when covered with a scarf, is scarcely perceptible. No inconvenience has been complained of by the wearers, except that, in one case, the heat was objected to; but this I hope at least to mitigate by fluting the inner surface."—*British Medical Journal*, Jan. 3, 1885.

By this apparatus the head is partly raised, and the neck is fixed.

As a simpler application of the same principle, Davy uses "plain cylindrical collars, much like swimming collars. In country practice,

Fig. 171.—Fleming's Pneumatic Collar.

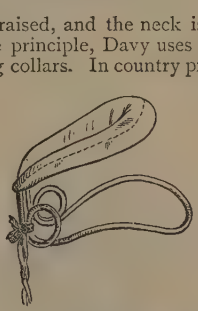


Fig. 172.—Moore's Collar. N.B. The lower extra turns have been lately added.

a dry piece of inflated gut answers very well, but in towns india-rubber is best, and is easily covered with fur, so as to imitate a victorine" (*British Medical Journal*, July 4, 1885), while Pughe has found very serviceable for poor patients "a collar made of soft leather filled with sawdust." Horsehair would be lighter and more elastic.

(*d.*) *Moore's Collar.*—A steel collar (Fig. 172), the invention of a blacksmith for his own little girl, is described by Clark, of Glasgow (Fig. 173). "It consists of two incomplete rings (A and B)—the upper for supporting the head, and the lower to rest on the shoulders. Being formed of one piece of steel, the two rings are continuous at the back; and the upright portions, passing from the lower to the upper, support the latter, and, when in use, support the head also. The lower ring is formed of round steel; but it is flattened for the upper, the flattening commencing about the middle of the vertical supports. The upper ring being formed of the ends of the bar is incomplete in front; but the extremities are joined by means of wire, or are loosely clamped, their ends being turned down to form flanges, so as to facilitate this connection. On the upper ring is placed a piece of millboard, and this serves to support a pad, sufficiently broad and thick to form a comfortable rest (Fig. 173). At the back there is a tie to keep the apparatus in place when in use.

It is, in many cases, found to be best to use a poroplastic collar, to give a firm resting surface for the shoulder ring, or sometimes it may be desirable to employ a Sayre jacket, carrying it over the shoulders, and placing the apparatus on this."

The support being on the vertical bars behind, the amount of elasticity depends on their thickness and shape. If need be, lateral supporting bars can be added to prevent the "give." The inventor's price for these instruments is 8s. each. His name is John

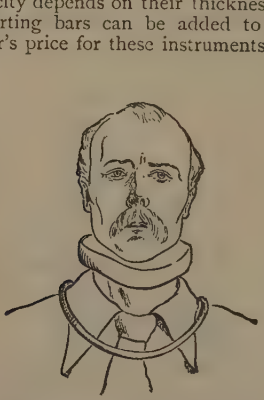


Fig. 173.—Moore's Collar applied.

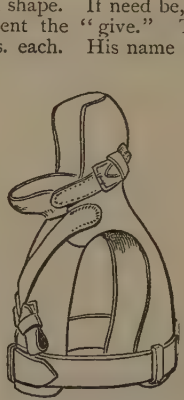


Fig. 174.—Leather Collar for supporting head (*after Owen*).

Moore, 11 Napier Street, Linwood, near Paisley. Hilliard & Son, of Glasgow, also supply them.

Two other collars have been advocated, and seem specially useful in giving rest to diseased vertebræ in the cervical or upper dorsal regions.

(*e.*) *Owen's Leather Collar.*—One described by Owen has been long used in the Great Ormond Street Hospital (Fig. 174). It is made of "undressed cow-hide, and is moulded on after being soaked in a pail of hot water. The hardened case is afterwards lined with chamois leather, and the front and back halves are made to overlap on the shoulders, and are fixed together by straps and buckles."—*British Medical Journal*, Oct. 31, 1885.

(*f.*) *Walsham's Combined Jacket and Collar of Poroplastic Felt* (Fig. 175), described in the same number of the journal, is somewhat similar to the above, but encloses the head and chest more completely. It is like a combined helmet and cuirass, and has been used with success.

(*g.*) *Jordan's Cervical Support.*—We cannot omit mention of Furneaux Jordan's "laminated plaster jury-mast (Fig. 166), which fixes the head and neck in one immovable block—so immovable

that, if the finger move the spine of the ilium, the head is moved at the same time; or if the head be turned, the trunk is turned with it. The jury-mast is a layered strip (eight to ten layers) about 45 or 50 inches long by 2½ or 3 inches wide. The deformity, if any, of cervical caries should be alleviated by horizontal mild pulley-extension, maintained by a chin and occiput sling for some weeks or months before the jury-mast is put on. It is applied thus:—The patient reclines on a narrow table and a mattress, with no pillow, pulley-extension with webbing being kept up until the plaster sets. The prepared multiple strip, rolled up at each end, after being dipped a few minutes in water, is unrolled, stretched, and smoothed; its centre is then applied to the forehead, well away from the eyes; the two ends are next carried to the back of the neck; when they cross, one end being carried under the neck first, then the other. They are drawn firmly enough to closely embrace the head and back of the neck; the ends are then brought forward and cross each other again in front of, or near, the sternal notch, where they are lastly fastened by a plaster jacket laid ready to be put on in the manner I have just described (p. 199). Before the laminated strip is applied, the hair is cut short, and a double strip of flannel, with cotton wool about the ears, is applied by the same method as the plaster strip. Before the strip sets, its upper margin should be partially everted from the angle of the jaw to the sternum, giving thereby much ease to the neck, especially when the jaw is moved."—*British Medical Journal*, July 15, 1882.

Fig. 175.—Poroplastic support for head and neck (*after Walsham*).

With regard to the disputed relative merits of plaster of Paris or poroplastic felt, the latter, if well fitted, is neat, light and strong, and is also porous; but it must be fitted on by a skilled workman, and often requires a model, or cast of the part. The former is much cheaper, nearly as light, equally strong and porous, and perhaps more lasting. Every surgeon or house-surgeon can apply a plaster of Paris jacket for himself.

CHAPTER XXIII.

JOINT-FIXATION AND FIXED APPARATUS—*Continued.*

Contents.—**C. Treatment of Joints after Excision**—(1) The Hip-joint — (2) Knee-joint—(3) Ankle-joint — (4) Shoulder-joint — (5) Elbow-joint—(6) Wrist-joint. **D. Various Forms of Fixed Apparatus**—Applications and Uses of Plaster of Paris—Various Splints (Watson's, The Bavarian, Croft's, &c., &c.)—Various Bandages (Starch, Water-glass, Paraffin, &c., &c.)—How to finish the Surface of Fixed Bandages.

C. Treatment of Joints after Excision.

AFTER excision joints require to be fixed in different ways, according to whether (in the lower limb) anchylosis or (in the upper limb) mobility is desired as a final result. Thus, while rigidity is essential for an excised knee or ankle, mobility is as important for an excised elbow or wrist. In the shoulder mobility, and in the hip rigidity, is less important. It is well to remember, however, that in any case for the first fortnight, the surgeon's chief care will be to secure the kindly healing of the operation wound, by ensuring for it rest and a-septicity.

(1) *After Excision of the Hip*, light extension applied to the thigh, in addition to the local support given by the dressings, is all that is needed. Extension is usually maintained for a month or six weeks after the operation; after which the patient may wear a Thomas' hip-splint for six or eight weeks longer before trying to walk.

Some surgeons prefer a long splint bracketed opposite the hip-joint, instead of extension as the treatment immediately after the operation.

(2) *After Excision of the Knee.*—Watson's splint has been much used (Fig. 176). Many surgeons either wire or peg the bones together at the operation to give them greater fixity.

Preparation of Watson's Splint.—Watson's splint for use after excision of the knee is made of "Gooch" long enough to extend from the ischial tuberosity to beyond the heel, and wide enough to surround the leg and thigh for two-thirds of their circumference, or less. At the knee it is scooped away laterally to a breadth of about 3½ inches, and opposite the heel and tendo Achillis it is cut away in the middle so as to end in two prongs, which pass down the side of the foot. (Esmarch ends the splint off where the prongs begin, and finds that he can steady the foot without them.)

The upper end is sometimes prolonged upwards at the outer side.

The splint is to be padded with lint or wool, except opposite the

knee (where movable padding will form part of the dressing), and it is then covered with mackintosh cloth sewn on.

Besides the splint, a suspension-rod of iron wire (No. 5 trade-wire-gauge) will be needed. This must be arched over the knee, bent up at the foot, and provided with one or more hooks for suspension.

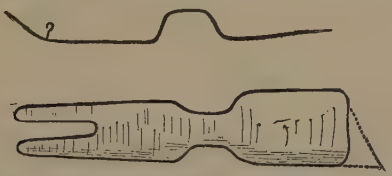


Fig. 176.—Gooch's Splint and Wire, ready for Watson's splint.

When the operation for excision has been completed and the dressing applied, the limb is wrapped in wool or boracic lint, and laid on the splint. A layer of plaster bandage is then applied, and after the wire has been placed in position, successive layers are added until sufficient thickness is attained.

While most surgeons immobilise the limb in a fixed apparatus at the operation, others wait until the wound has partly healed before so doing, and meanwhile steady the parts in a box-splint (see p. 141).

(3) *After Excision of the Ankle*, some form of interrupted splint must be employed (see Figs. 161, 162). A Macintyre splint may also be used with advantage (Fig. 120).

(4) *After Excision of the Shoulder*, no splint is required, the arm being bandaged to the side with the hand laid across the opposite breast.

(5) *After Excision of the Elbow*, it is usual to lay the arm on a pillow, and to steady it midway between pronation and supination. Some advocate a form of interrupted splint, while others put on a light extension. Passive movements should be omitted for from ten to fourteen days, or more, after the operation, and should then be slow and gentle—one such movement being sufficient at each dressing. Any movement which excites inflammation or causes bleeding will increase the danger of after-stiffness. Later on Professor Chiene advocates drawing up the arm to the head during the day, by causing the patient to wear an elastic bandage, while at night extension with weight and pulley gradually draws it down again.

(6) *After Excision of the Wrist*, the hand and fore-arm should be laid on a splint with a prominent pad under the palm; for the first two or three days the fingers may be confined, but after that they and the thumb should be left free, while the hand and fore-arm are steadied on the splint.

D. Various Forms of Fixed Apparatus.

In the sections on Joint-fixation, we have described Sayre's plaster jacket, F. Jordan's laminated plaster method applicable to the spine and elsewhere, and the methods of cutting and applying pasteboard or poroplastic splints to the elbow, knee, and ankle. There are, however, additional methods and forms of apparatus which may be here described with advantage.

(1) **Plaster of Paris** may be used as for the spinal jackets for any part of the body.

(*a.*) *General Application.*—After a layer of absorbent cotton-wool or boracic lint, the part must be wrapped with the open gauze bandage charged with plaster, and soaked in water just before use; eight or nine plies are needed for an adult, five or six for a child; or successive layers of ordinary bandage and plaster-cream may be laid on thus:—After a layer of bandage, a layer of plaster is smeared on, and so on till a thickness of ½ to ¾ in. is attained. Instead of the bandage, layers of jute or absorbent wool may be soaked in the freshly-made plaster, and applied to the part, a method which is also useful in strengthening the weak places of any plaster splint.

An objection to any of these methods, however, is the trouble involved in removing the splints. The bandage must either be sawn through, or the plaster must be softened by pouring a few drops of hydrochloric acid upon it, when it may be cut with a knife. To obviate this difficulty in removal, several methods have been advocated in which the part along the front of the limb is left free of plaster. Neudörfer's plan is one of the simplest. "Compresses of linen or of lint (we may add of tow, jute, or wool) are dipped in plaster of Paris of the consistence of a common poultice (*sic.* cream). These are then placed longitudinally on the limb, first on the upper, then on the under part. A few turns of a bandage keep them *in situ* till the plaster is set; to prevent contiguous edges adhering, they are slightly greased, or a slip of greased lint is placed between them."

If the pieces were made lateral, with an interval on the front and back, the splint when set would thus be in two halves, and could be removed by merely cutting the binding cotton bandage along the front, the back part of the same acting as a hinge.

Instead of mixing the plaster with water *before* it is incorporated with the lint or tow, dry plaster may be first worked into folds of lint, layers of gauze, absorbent wool, jute, or tow (see F. Jordan's laminated plaster splint, p. 198), of the required size. These are then to be soaked in water, gently squeezed, and, having been laid on to the part, are to be bandaged into the shape of the limb.

(*b.*) *A very simple plaster bandage for the leg and foot* may be made as follows:—Make two equal laminated plaster strips of nine layers of gauze each. *Length*, from dorsum of foot under the sole and up opposite side of leg to above or below knee as required; *breadth*, half circumference at ankle, after allowing for padding. See that

the limb is steadily held in the required position by assistants. Now wrap it evenly in absorbent wool, boracic lint, or flannel. Next soak one of the two laminated pieces, and apply it down one side of the leg, under the sole and round to the dorsum. The assistants who maintain the leg in position can keep this piece in its place while the other is applied in like manner. In order to facilitate after removal, the parts *on the dorsum* which overlap should be separated by a few folds of paper (the overlapping on the sole is an advantage).

A roller-bandage is now to be applied over the whole while it is still soft. When the plaster has set (ten minutes) the assistants may let go; next day when it is dry, the splint will be perfectly firm. In the interval no unnecessary strain should be put upon it.

When a window has to be left for dressing a wound, the separate pieces in many of the above methods can be easily ranged round it; but when plaster bandages are wrapped continuously round a limb, the site of the window must be indicated by placing over the wound a ball of wool, on which the plaster is afterwards cut out.

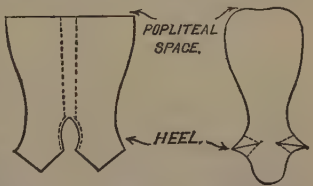


Fig. 177—*a*. Pattern for Bavarian Splint. *b*.—Kingman's Splint (*after Gamgee*).

(*c*.) *The Bavarian Splint* is made of a double layer of strong flannel, stitched along the back, and shaped as in the diagram (Fig. 177, *a*). The leg being held in position, the flannel is applied with the stitch behind. The inner layer is brought over and pinned in front, while the outer layer lies back. Plaster of Paris is next mixed, and spread over the outer surface of the inner layer, to the thickness of about half an inch; the outer layer is then brought over, and a firm roller-bandage is applied.

(*d*.) *Croft's Splint* is a modification of the above, and is much used in London. A *double* pattern for each side of the leg and foot is cut from washing flannel. A flat surface spread with old newspaper or mackintosh cloth must be at hand. Beginning with one half of the splint, one piece of it is taken, and that face which is to lie next the leg is laid on the flat surface provided. Plaster of Paris is then mixed, and the other piece is soaked in it, while plaster of Paris is also spread on the upper or outer face of the first piece. The soaked piece is then laid over the plastered face of the first piece. A similar procedure is meanwhile being executed by assistants with the other half of the splint. The two halves are then laid against the limb, and bandaged into position. Thus the surface of the inner piece next the limb has no plaster, while the second and outer piece is saturated through and through.

(*e*.) *Kingman's Posterior Laminated Splint* is described by Gamgee in his work on *Wounds and Fractures* as follows:—

The shape of the layers of gauze is obtained thus—"The leg being bared, a piece of the gauze is placed beneath it, long enough

to reach from the knee to a point about 10 inches below the heel, and wide enough to encircle the calf. Upon this gauze, mark out with a lead pencil a pattern similar to the outline of the accompanying sketch (Fig. 177, *b*) of such size that it shall cover the posterior two-thirds of the limb. Place the pattern upon six or eight layers of the same material, and with a pair of shears cut them together."

He lays these layers on one another, with freshly-mixed plaster between (the plan with the dry powder, afterwards wet, would seem better), and then places the soft mass beneath the limb previously padded, and after folding it up applies a roller-bandage. This splint is open in front. Flannel or lint, soaked in plaster, of the desired shape, would probably do as well.

(*f*.) **Pasteboard or Poroplastic Splints.**—These, besides being shaped to the sides of the limbs, may be applied from the back, making a trough opposite any bend in the limb. The material must be incised at right angles to its long axis. When the splint is then moulded into position, there is an over-riding at the place of the cut, which gives greater strength than if the piece had been cut out (see also pp. 192 and 193).

(*g*.) **Starch Bandage.**—This is seldom applied by itself. More generally it is used over a pasteboard (or poroplastic) splint, which gives it greater rigidity, especially as the starch takes about twelve hours to dry.

There are required—household starch, a bowl and spoon, kettle of boiling water, some cold water, roller-bandages, and pasteboard.

First wrap the limb in lint, wool, or flannel, then soften the pasteboard splints, and mould them into place with the fingers. Make the starch by first thoroughly breaking it down into a thick paste with cold water in the bowl. In this stage it will be white. Pour in now boiling water, and stir well. The starch will swell up and turn of a bluish tint. Add more water till the whole, being thus changed, pours easily out of the spoon. As it cools it will set into a jelly, but it may be used in either the liquid or the jelly state. Powdered boracic acid, about 10 per cent., may be added along with the boiling water with advantage.

A layer of roller bandage having been now firmly applied over the pasteboard splint, is then smeared over with starch. A second layer of bandage is in turn smeared over, and so on for three or four layers. To dry the starch, lay the limb near the fire, or place hot bottles alongside of it.

(*h*.) **Water-glass Bandage.**—This is a silicate of soda, dissolved in excess of caustic alkali (according to Wagstaffe, silicate of potash is not so good). It may be used instead of starch, and dries more quickly, although it does not harden completely for two or three days. It is light, strong, and cheap (4d. to 6d. per lb.) May be ordered from most wholesale druggists.

Water-glass may be used with or without pasteboard. When extra hardness is needed, whiting, powdered chalk, slaked lime, or magnesia should be mixed with it to the consistence of batter. As in the starch bandage, after a layer of roller-bandage, the water-

glass alone or mixed with whiting should be smeared on with a brush or sponge, then another layer of bandage, and so on for three or four layers. (Esmarch advises the use of a freshly-made concentrated solution of neutral silicate of potash.) By moistening the water-glass, it may be softened previous to cutting it for removal.

(*i.*) **Gum and Chalk.**—A mixture of mucilage and powdered chalk of the consistence of paste may be used instead of starch or water-glass; but it has no advantage over these, and is dearer.

(*k.*) **Paraffin Bandage.**—Paraffin may be applied with a brush in the melted state in the same way as starch. Although not so rigid as water-glass, it has the advantage of being waterproof; and though more expensive than most of the above, it may be boiled out of old bandages, and used over again.

(*l.*) **Finishing the Surface of Fixed Bandages.**—Plaster of Paris may be glazed with switched white of egg or with size. Its surface may be rendered waterproof by a layer of paraffin, or by several layers of boiled linseed oil, damar, or shellac varnish. In a similar way, a waterproof coat may be applied to any of the other fixed bandages, and is especially needed for children.

In the neighbourhood of a window cut for dressing a wound, Esmarch advises a packing of wool saturated with collodion to prevent the soaking in of discharge. In the absence of collodion, some of the other waterproof materials above mentioned might be substituted.

CHAPTER XXIV.

THE URINE.

Contents.—Importance of a knowledge of the state of the Urine in Surgical Cases—**A. General Conditions to be Noted**—Quantity of Urine, Pain associated with Micturition, Odour, Colour, Transparency, Reactions, and Specific Gravity of Urine. **B. Presence of Abnormal Substances in Solution**—Albumen; Bile; Sugar; Blood; Pus—Urinary Deposits. **C. Examination of the Urine**—Preliminary—For Abnormal Substances—For Deposits.

Importance of a Knowledge of the State of the Urine in Surgical Cases.—Although the investigation of the Urine is more usually considered as forming a part of the duty of the *Physician*, yet there can be no doubt whatever that a careful examination of this excretion, and a due appreciation of its various abnormalities, is of the utmost importance to the *Surgeon*. Apart from the necessity of studying the urine in "surgical" affections of the genito-urinary tract, there are many cases where the state of the kidneys as indicated by the urine may determine the advisability or not of an operation, and may very materially affect its prognosis, if

it be undertaken. As a report of the urine is a necessary complement to most surgical "cases," a chapter devoted to the investigation of the urine from an especially surgical point of view seems to be called for in the present work.

A. General Conditions to be Noted.

The general questions involved in the examination of the urine will be briefly discussed before the methods of investigation are given in detail.

(1) **Quantity of Urine.**—This is estimated by collecting and measuring the urine passed in twenty-four hours, and is important—(*a.*) because deviations from the normal are alone often indications of disease; (*b.*) because without a knowledge of the quantity, no reliable conclusions can be drawn from a knowledge of the specific gravity.

The **normal amount** of urine for an adult varies from about 35 to about 65 ounces in twenty-four hours—on an average, about 50 ounces. The quantity will vary with that of the fluid drunk and with the extent of its excretion by the skin, lungs, and bowels. This latter factor, as well as the patient's usual quantity, must be taken into account before any conclusions as to abnormality can be arrived at, although, of course, an insatiable thirst and appetite are themselves symptoms of Diabetes Mellitus.

Variations in the Normal Excretion.—An important matter is the varying rate at which urine is excreted during the twenty-four hours by the kidneys.

Roberts has shown* that the solid and fluid constituents of urine are much increased after meals, and diminished during fasting and sleep. From this two deductions may be drawn, which might be of service in surgical cases—(1) That the urine, like the fæces, may be reduced by a sparing solid as well as liquid diet, in cases where it might be thought necessary; and (2) that where urine had to be repeatedly drawn off by the catheter, the meal-hours might be so planned to suit the surgeon's time, that his visits an hour or so later would relieve the bladder after the increased flow had occurred.

Urine is **diminished** in feverish conditions, especially those associated with sweating; in cirrhosis of the liver; in heart-disease, when it results in backward venous congestion, or lowered arterial blood-pressure; in acute Bright's disease, or in the acute interstitial nephritis reflexly caused by irritation to the urethra, or in the later stages of all forms of chronic Bright's disease; in rapid removal of fluid from the blood, as in severe hæmorrhage, extensive serous effusions, or violent diarrhœa; in peritonitis, and in severe irritation of the splanchnic nerves, as in strangulation of the bowel, and in

* *On Urinary and Renal Diseases.*

renal or hepatic colic; also in blockage of the ureter by a calculus or by the pressure of a tumour.

Complete Suppression of Urine—a condition of the utmost danger—may occur not only in severe forms of Bright's disease, and in the course of any violent fever, but also in the congestions and inflammations of the kidney which are apt to follow even the simplest operations on the urethra or bladder, especially when there has been long-standing backward pressure in the pelvis of the kidney from obstruction to the outflow of urine, due to stricture or enlarged prostate. Suppression may also be caused by an overdose of turpentine, nitric acid, or other irritant, or by the absorption of cantharides from a large blister.

An **increased quantity** of urine may be due to diabetes insipidus or mellitus; to the early stage of any degeneration of the kidneys, of which it is sometimes the first symptom; to the intermediate stage of cirrhotic kidney associated with increased arterial tension; or to cystic degeneration of the kidney and double hydro-nephrosis.

The **frequency of micturition** should always be noted, as, taken along with other symptoms, it is an important aid in diagnosis.

Like the quantity of urine, the frequency of micturition may be relative, but when there is an increase from the patient's previous habit, or when the frequency is manifestly above the normal, some cause must be looked for.

The increase in frequency may be attributed solely to a larger quantity of fluid passed, but besides, its explanation may be sought

(1) In the irritating quality of the urine, when highly concentrated, charged with acid, or loaded with sugar.

(2) In irritations of the genital organs and perinæum, as in congenital phymosis and adherent prepuce, and occasionally in gonorrhœa and piles. In children from worms in the rectum.

(3) In obstruction to the outflow of urine, as in stricture of the urethra and enlargement of the prostate (mostly at night).

(4) In irritation of the bladder from cystitis, presence of a calculus or foreign body, tumour or tubercular deposit in the bladder-wall, or cellulitis near the bladder. Also in pressure against the bladder-wall from tumours, misplaced uterus, or pelvic accumulation of fluid—*i.e.*, pus or blood.

(5) Irritation of the kidney, as in renal calculus, or tubercular pyelitis.

(2) Any **Association of Pain with Micturition** should also be observed and recorded. Pain *before* micturition indicates sensitiveness to stretching of the bladder-wall, generally from cystitis; *during* micturition, some obstruction to the flow, as stricture, also irritating quality of the urine, a highly sensitive urethra as in urethritis, or a caruncle in women; *after* micturition, generally some irritation at the neck of the bladder as from a calculus or tubercular deposit there, or from an inflamed prostate.

Almost all irritations of the neck of the bladder and in the urethra cause referred pains at the point of the penis, and those in the kidney and ureter often cause similar pains shooting down to the testicle and scrotum in men, and towards the groin in women.

(3) **The Odour of Urine** is peculiar to itself; familiarity with it is necessary for the detection of abnormalities, and for diagnostic purposes, as it is often important to know whether certain doubtful fluids contain urine or not. Urine alkaline from decomposition smells of ammonia, while when alkaline from fixed alkali, "it has a sweetish aromatic odour like that of the fresh urine of the horse or ox" (*Roberts*). Blood or bloody discharges give it a stale offensive odour; turpentine, one like that of sweet violets; while copaiba, cubebs, and sandalwood oil, communicate their own peculiar odour which is easily recognised.

(4) **The Colour of Healthy Urine** varies from a pale straw tint to a full amber-yellow in different individuals; the colour is *deepened* by feverish or rapidly-wasting conditions, and by muscular exercise and severe sweating. *Pale* urine occurs from dilution when much fluid has been drunk, also in anæmia, diabetes, chronic forms of Bright's disease, and after hysterical or nervous paroxysms.

A pinkish red pigment called *purpurine* is found in the urine of patients when feverish, and when suffering from severe organic disease—especially of the liver; it has a strong affinity for uric acid and urates, and gives them their familiar brick-red colour. A black pigment—melanin—accompanies sometimes melanotic tumours. A dark purple band is seen at the junction of the urine and the nitric acid, when the latter is allowed to flow slowly into a test-tube containing the suspected urine. When taken internally, rhubarb and senna colour the urine of a brownish-yellow, logwood of a reddish, and santonin of a bright yellow tint.

Carbolic Acid when absorbed into the blood tends to irritate the kidneys, and gives to the urine an *olive-green colour*, varying in depth. The colour does not usually appear until some time after the urine has been passed.

Creosote and the external use of tar ointment may also cause darkening of the urine.

Blood, when first added to urine, colours it *red*. Should the reaction be acid, the hæmoglobin is soon altered, and gives a dark or *smoky tint* to the urine; in a urine alkaline from fixed alkali the colour is said to be unchanged. In ammoniacal decomposition of urine it is soon changed.

Bile Pigments in the blood are excreted by the kidney, and give a *dark yellowish or greenish hue* to the urine, which froths easily and shows a corresponding tint on the bubbles.

As bile pigments can be detected in the urine both before and after any recognisable changes in the colour of the skin, their presence may be of great service in detecting or tracing obstructive jaundice, as from gall stones or pressure on the bile ducts.

In large quantities bile pigments turn urine of a colour varying from a saffron-yellow to a dark olive-green.

(5) Urine is normally quite **transparent**. In an acid urine, an *opacity* which only appears after cooling will be due to excess of

urates, while an opacity seen at first may be due to oil-globules, as in chylous urine or fatty embolus, to the effect of copaiba or cubebs taken internally, or, most frequently, to pus.

When **pus** is detected, its source should be ascertained if possible. That from the urethra will be swept out with the first few ounces of urine, which should therefore be collected separately. If the remainder of the urine comes away clear, the diagnosis is pretty certain, but if not an effort may be made to distinguish between pus from the kidney and that from the bladder. By first washing out the bladder and then tying in a catheter, a sufficient sample may be obtained. If it be uniformly turbid, the source of pus will be above the bladder; if clear, probably in that viscus (*Thomson*).

In an alkaline urine, turbidity generally indicates decomposition, with a ropy deposit of altered pus and mucus.

(6) The **Reaction of Urine** in health is generally acid, due to acid phosphates and urates, and also to free acids—such as lactic, oxalic, and acetic.

After food has been absorbed, the reaction becomes more or less alkaline as it leaves the kidney, although after mingling with the acid urine in the bladder, it may never be actually alkaline when passed from the urethra. The secondary effect of a meal, especially of animal food, is to increase the acidity of the urine. It has been pointed out that the acidity of the urine varies inwardly with the secretion of the gastric juice. When there is much acid in the stomach, a less quantity is excreted by the kidneys, and *vice versâ*—opium increases acidity of urine (*Harrison*).

Urine may be *permanently alkaline* (1) from the presence of large quantities of alkaline phosphates, as occurs sometimes in patients when in an anæmic and depressed state. (2) From the internal use of alkalies (caustic and carbonated) and alkaline salts of acetic, tartaric, citric, malic, and lactic acids. (3) From cold bathing. (4) From ammoniacal decomposition where, through the agency of micro-organisms, urea unites with water to form carbonate of ammonia.

The reaction of urine often throws great light upon clinical symptoms.

An *unduly acid* condition seems chiefly to excite the mucous membrane of the urinary tract, and over-stimulate its nervous and muscular activity, producing symptoms very like those of calculus in the kidney or bladder. In some cases it may be the cause of small quantities of blood and pus in the urine, which still further complicate the diagnosis. An *alkaline condition* from any of the above causes except the last (decomposition) seems to have no effect on the urinary passages, and is not liable to form any calculus. On the other hand, urine alkaline from *ammoniacal decomposition* is a strong irritant of the mucous lining of the whole urinary tract, sooner or later inflames it, and tends to deposit phosphatic salts. An important relation has been traced by Lister between the state of the mucous membrane and the action of micro-organisms. If the former be healthy, the urine seems able to withstand the action of micro-organisms even when implanted

within the bladder; but if it be already irritated or inflamed, the fermentative process is easily started, and, once begun, it still further destroys the resisting power of the mucous lining, and decomposition goes on unchecked.

In most cases, contamination of urine by micro-organisms is produced by the use of dirty catheters, the risk of contamination being greatest in those cases where instrumentation is most required—*i.e.*, in stricture, prostatic enlargement or paralysed bladder, or when a calculus is present. Besides the irritating effect of decomposing urine, the tendency to deposit ammoniaco-magnesian phosphate adds greatly to the patient's danger; a previously existing calculus will be increased, or a new one formed, or the lining membrane of the bladder be encrusted with phosphates. Although uric acid calculi are slightly soluble in urine rendered artificially alkaline, no method of dissolving phosphatic calculi has yet been discovered, either by injections into the bladder, or by the administration of drugs, hence a phosphatic coating stops any attempt at removing a calculus by other than surgical means (*Roberts*).

An unduly acid state of the urine may be caused by (1) an increased quantity of uric acid as in gout. This is clinically important as indicating a liability to the formation of a calculus in the urinary passages, or as causing symptoms like those due to a calculus. (2) By excess of lactic acid due to acute rheumatism. (3) By acid fermentation, occurring for some hours or days in healthy urine, and preceding the ammoniacal decomposition which sooner or later sets in. If, however, contamination, from previously ammoniacal urine, occur, the alkaline change will begin at once. This omission of the acid fermentation is liable to happen in certain weakly states of the mucous membrane of the bladder, or when the urine is neutral or alkaline to begin with.

The **Specific Gravity** of the urine, taken along with the total quantity passed, is a direct indication of the activity of the kidney-substance and of the quantity of solids excreted. Necessarily, it will vary with the amount of fluid drunk, and of that removed by the skin and bowels.

As the relative and absolute amount of solids excreted varies from time to time according to meals, fasting, and exercise, an average can only be arrived at by mixing together the whole urine passed during twenty-four hours. In this way the total quantity has been found to average about 50 ounces, and in like manner the average specific gravity has been found to be about 1,020, taking water as 1,000; variations, however, from 1,006 to 1,030 are not uncommon.

Apart from varying quantities of fluid drunk or excreted by other channels, a *high specific gravity*, with a pale urine, points to diabetes mellitus with sugar in solution, with a dark urine to feverish conditions with urea in solution; while a *low specific gravity*, with a pale urine, leads to a suspicion of chronic kidney disease, and possibly albumen. Even where no albumen can be detected, a persistently low specific gravity should always make a surgeon anxious.

The **kidneys** in such cases are not doing their work properly, and hence not only impair the patient's general health, but are apt to fail

should an operation involve a strain upon their functions, and to break out into active disease on slight provocation. As the kidneys may be considered one of the chief means of purifying the blood, any septic condition is apt to throw a severe strain on their functions. Indeed, in such cases, micro-organisms and their products have been seen when looked for in the urine, and large quantities of micro-organisms have been found *post mortem* in the kidneys. Hence the special importance of healthy kidneys in septic wounds, as well as in operations on the genito-urinary tract.

When pressure within the ureter is increased, the excretion of solids is lessened before the current of fluid is affected—hence a *lowered specific* gravity may sometimes point to an *obstructed ureter*.

B. Presence of Substances in Solution not found in Healthy Urine.

(1) Albumen is to be detected by some of the methods to be afterwards described.

Although traces are occasionally found in the urine of healthy persons, the presence of albumen is always to be looked on with suspicion, and demands an investigation into its cause. The harmless forms of albuminous urine have been classified as those due to diet, excessive exercise, or special paroxysms (*Stewart*).

Other causes are various—(*a.*) Due to pus, blood, or serum, poured into the urinary tract from any cause. Even after blood-corpuscles have ceased to leave the vessels, the presence of albumen in the urine may show that serum still escapes. It is often very difficult to calculate how far the albumen in any urine is due to the pus and blood mixed with it, and how far to diseased kidneys.

(*b.*) To congestion of renal veins from mechanical obstruction (according to some authors).

(*c.*) In the course of pneumonia, and other inflammatory conditions, attributed to renal congestion either from alterations in the blood, or from the presence of micro-organisms and their products.

(*d.*) To leucorrhœal discharges, or the menstrual flow, which may be followed by albumen in the urine for some days after every other recognisable trace of blood has disappeared.

(*e.*) To disease of the kidney, acute or chronic. A scanty, high-coloured urine, with a considerable quantity of albumen—especially if there be also a deposit of blood-corpuscles and tube-casts, as well as general fever and pain in the loins—will point to acute inflammation of the kidney. This condition, however, is not likely to come under the surgeon's notice unless it be caused by an operation involving the urinary tract, or arise in the course of other surgical treatment.

If the urine be pale, of low specific gravity, and normal or deficient in amount—especially, also, if there be a deposit of tube-casts—chronic renal disease must be suspected and reckoned upon.

(2) Bile in the urine may be due to obstruction to some of the bile-ducts within, or outside of, the liver. It may be suspected in a greenish-brown coloured urine, with a tinted lasting froth.

To distinguish between bile-pigments and those caused by rhubarb or santonin, an alkali may be added, when the former will be changed to a dirty brown, and the latter become a deeper red.

It is well to remember that, although the presence of bile in the urine may point to temporary or permanent obstruction of the hepatic or common bile-ducts by gall-stones or otherwise, the absence of bile by no means excludes a blocking of the cystic duct, or a filling-up of the gall-bladder with gall-stones, or a former temporary obstruction of the other ducts. In all cases of doubt, the test for bile-pigments to be afterwards given must be applied.

(3) **Sugar** in the urine may be temporarily present in small quantities, or be found there in excess as a constant ingredient. In the latter case, it indicates diabetes mellitus, which sometimes has important surgical aspects.

In some cases an intractable eczema is caused by it on the parts near the meatus urinarius (in both sexes); in other cases it is associated with numerous boils or carbuncles, and sometimes with gangrene. More recently sugar in urine has been found temporarily present in many acute inflammations, and may be considered an indication of commencing suppuration, so as to be a great help in the diagnosis of obscure cases. Temporary glycosuria has often been observed after inhalation of chloroform, and is of no importance.

(4) **Blood** in the urine—hæmaturia—often of the greatest importance in surgical diagnosis, may be due to lesions or inflammation at any part of the urinary tract, from the kidney to the orifice of the urethra. When blood gets immediate access to the urethra, it may be passed independently of any urine, or be mingled with the first few ounces of it only, the rest being clear. Such a relation would be seen in a *partial* rupture of the urethra (if complete, there would be no subsequent flow of urine); in rupture of the vas deferens through muscular strain (*Hilton*); or in the course of severe gonorrhœa. Vesical hæmorrhage is mostly seen at the end of micturition; while in renal hæmorrhage the blood, unless in very large quantity, is uniformly mixed with the urine and darkened in colour.

The acid of urine soon changes the bright-red hæmoglobin into a dark brown or black colour; hence the smoky tint considered characteristic of hæmaturia. From the colour, an idea may be gained as to the source of the blood; because the longer it has been mingled with the urine, the more will it be changed, and *vice versâ*. Bright-coloured blood in an acid urine must, therefore, have come from the urethra, or from the bladder or kidneys just before it was passed; while darkened blood pigment will have been shed from the kidneys or ureters, or from the bladder sometime before being passed. Clots from the ureter, urethra, or pelvis of the kidney, when floated out in a basin of clean water (*Hilton*), will resemble casts of those parts, or of calculi which caused the bleeding (in the latter case particles from the calculus may adhere to the clot), while from the bladder they will be irregular. Blood in minutest quantity can be detected with the microscope by its corpuscles, when no change in the colour of the urine can be traced.

Following an injury to the *loin*, or a strain, hæmaturia may indicate one or other of the following renal conditions (*Morris*):—

(*a.*) Contusion of the kidney.

(*b.*) Congestion of the kidney, similar to that produced by turpentine or cantharides, following the injury, or owing to the displacement of a previously encysted calculus.

(*c.*) Congestion due to an embolus, or thrombus, the result or accompaniment of the injury.

(*d.*) Kidney uninjured at first, but secondary inflammation spreading to it from surrounding damaged tissues; here hæmaturia appears late.

(*e.*) Shaking of the kidney. This may cause hæmaturia in some persons without, but generally indicates, a renal calculus.

Other sources of renal hæmorrhage are calculi, new growths, tubercular or putrefactive pyelitis. In addition, hæmaturia, apart from an injury or from an embolus, may be expected in acute nephritis of whatever kind; in the course of chronic nephritis, from direct or indirect effect of a calculus, or from excess of uric acid in the blood.

When the source of bleeding is the *bladder*, a calculus, a simple or malignant tumour, cystitis, tubercular ulceration, or (after a severe injury) a rupture, may be traced as its cause.

Bleeding often comes from dilated veins about the prostate in old men, and as the blood may easily pass back into the bladder, the diagnosis may be difficult. Hæmaturia and serious lesions of the urinary tract are sometimes traced to a parasite (bilharzia hæmatobia), and bleeding occasionally follows the sudden evacuation of an over-distended bladder.

From the *urethra*, besides the causes of bleeding already noticed, a new growth, urethral calculus, or chancre, may be accountable.

In women the menstrual flow or blood from a tumour at or near the cervix, escaping by the vagina, may contaminate the urine and simulate hæmaturia.

(5) **Pus** in the urine—pyuria—like blood, may have its source in any part of the urinary tract. Its effect upon the transparency of urine, and the simple means available for tracing its source, have already been described under the head of *Transparency of Urine*, p. 214. Coming from the kidney, pus may indicate pyelitis (by extension of septic mischief from the bladder, from tubercular deposit, or from the irritation of a calculus), a tumour, suppuration within the kidney, or acute nephritis. When the bladder is its seat, it may be due to cystitis, tumours, tubercular ulceration, a stone, or bilharzia.

From the urethra, gonorrhœa or gleet is its usual source, sometimes a urethral abscess, and rarely a tumour, urethral chancre, or secondary syphilitic ulceration. Bilharzia hæmatobia is said to lodge most frequently in the prostatic urethra.

The Occurence of Urinary Deposits.—After urine has been allowed to cool and stand for several hours, a deposit is generally seen, varying from a delicate cloud of mucus in health, to distinct sediments in disease. The naked-eye and microscopic characters of these

must be noted. The materials of some of the deposits are formed in the urine before it cools, while those of others only appear after cooling.

Those which appear *before*, are pus, and occasionally crystals of uric and oxalic acid, when in excess, entangled in mucus.

In an alkaline urine, crystals of ammonio-magnesian phosphate may be seen. Where a deposit occurs before cooling, there will be greater risk of calculus formation within the body, although, as V. Carter has shown, it is probable that calculi are not the result of aggregation of the ordinary crystalline forms of the various substances, but of the combination of a modified crystalline form with mucus in a way not as yet clearly understood.

After cooling the commonest deposit is one of amorphous urates of soda, ammonia, lime, or magnesia.

These may be seen under many conditions—such as excessive muscular exercise, congestion of the liver, any feverish condition, errors of diet, and from dyspepsia. When visible continuously for some time they indicate liver derangement, and being premonitory of gout and uric acid formation, require treatment (*Murchison*). If co-existent with piles they would call for an improvement in the hepatic circulation.

Besides urates, crystals of uric acid or oxalate of lime may be deposited, one or both, generally with urates also. Their deposit will depend partly on the quantity of acid present, partly in the acidity of the urine. In an alkaline urine, phosphate of lime in an amorphous or partly crystalline form may be seen, also crystals of triple phosphate; in ammoniacal decomposition the triple phosphate is always present.

More or less *mucus* is always associated with any of the above deposit, and holds them together. After urine has stood for a time, a *scum* often appears on its surface. This may consist of urates, phosphate of lime, triple phosphates, micro-organisms, or of oil-globules.

The latter may be seen after severe fractures attended by crushing of the medulla, and, according to some authors, to a certain extent in most fractures. Oil-globules are present in the circulation, and are excreted by the kidneys. They occasionally give rise to the severe symptoms associated with fatty embolus, in the later stage of diabetes, and in the rare and obscure disease called chylous urine.

(The observer must, of course, exclude the possibility of the oil having been introduced into the urine by the lubrication of instruments.)

C. Examination of the Urine.

Where possible, for reasons already given, the whole urine passed in the preceding twenty-four hours should be collected and measured; failing this, morning and evening urine may be mixed when the specific gravity is wanted. Urine after fasting is most acid; that after meals will have the highest specific gravity, and will reveal the smallest traces of albumen.

Where pus is suspected, urine from a single micturition should be collected in separate vessels.

Preliminary Examination.—After the total quantity of urine for

twenty-four hours has been measured, a portion should be placed in a narrow cylindrical jar, holding about a pint, and be allowed to stand; in an hour or two afterwards the examination may be made, noting:—

1. *Colour.*
2. *Odour.*
3. *Froth*, whether permanent (*i.e.*, indicating albumen) or not, or if tinged with bile.
4. *Reaction.*—This is to be tested with litmus paper.

The ordinary blue colour will be changed to red it the reaction be acid; and, if previously reddened, will be turned blue again by an alkaline reaction. Where ammonia is the cause of alkalinity—as in decomposition—it may be driven off with gentle heat so as to allow the red colour to re-appear. With other forms of alkalinity, this is not possible. Violet litmus paper available for either acid or alkaline reaction is sometimes used, while instead of reddened litmus paper, yellow turmuric paper—turned brown by an alkali—is sometimes employed.

5. *Specific Gravity* is generally ascertained by means of a urinometer, or hollow glass cylinder, weighted with mercury below and having a graduated stem above. In water the stem should sink as low as the mark 1000; the more solid matter suspended in any fluid, the higher will the stem rise. As the fluid tends to rise up around the stem, the figures should always be read off by placing the eye on a level with the surface of the liquid in the jar. The urinometer should be entirely immersed once or twice before being read off, and should not be allowed to rest against the sides of the vessel.

Examination for Substances in Solution.—Next, we test for substances in solution.

(*a.*) **Albumen**—*i.e.*, serum albumen, which for practical purposes is the only form whose presence is important.

(*a*) *By Boiling after Acidulation.*—"A test-tube is charged with about 3 fluid drachms (10 cc.) of urine. To this is added a single drop of acetic acid. The upper half of the column is then heated to ebullition. If albumen be present, the upper boiled portion of the column will show opalescence in contrast with the lower half, which remains unchanged. If the urine be alkaline, it should be carefully neutralised by adding successive drops of acetic acid, until the litmus paper shows a distinct, but slight, acidity, and then the final drop of acid is added before boiling. Even if the urine possesses its natural acidity, it is better to add a drop of acid, if you want to bring out the maximum sensitiveness of the boiling test. When performed with these precautions, the boiling test is the most sensitive and the most reliable of all albumen tests" (*Roberts*).

If urates be present, boiling alone is sufficient, as the urates indicate acidity. Heat redissolves the urates, and as the boiling-point is approached a cloud of albumen will appear, if present.

Should the urine have been alkaline, or faintly acid, when boiled, a cloud of phosphates is likely to appear. This cannot be distin-

guished from albumen until a few drops of nitric acid are added, when the phosphates will be dissolved, and albumen, if present, coagulated.

(β) *Nitric Acid.*—"Nitric acid is an extremely delicate test for albumen, and is the first test to use in all cases except when the urine is turbid from urates. The best manner of applying it is to fill a test-tube to the depth of about an inch; then, inclining the tube, to pour in strong nitric acid in such a manner that it may trickle down along the side of the tube to the bottom, and form a stratum some quarter of an inch thick below the urine. Added in this manner, there is scarcely any mingling of the two fluids, and if albumen be present, three strata or layers will be observed—one perfectly colourless, of nitric acid at the bottom; immediately above this an opalescent zone of coagulated albumen; and at the top the unaltered urine. If there be only a trace of albumen, twenty or thirty minutes elapse before the opalescent zone becomes visible."

Cautions!—"In concentrated urines, and especially in febrile urines, the addition of the acid is apt to precipitate the amorphous urates, and thus to occasion a turbidity which might be mistaken for albumen."

"Albumen begins to coagulate immediately above the stratum of acid, and the turbidity spreads upwards; but the urates first appear at or near the surface of the urine, and the opacity spreads downwards. Heat also readily resolves the doubt; for urates speedily disappear when the urine is warmed, but turbidity from albumen is not affected by heat."

Nitric acid may increase the opalescence commonly present in the urine of patients who are taking cubebs and copaiba.

When excess of urea is present in the urine, nitric acid produces a crystalline deposit of nitrate of urea after the fluids have been some time in contact.

Too small a quantity of nitric acid will fail to coagulate the albumen; a large quantity, if *mixed* with the urine, will re-dissolve it.

(*b.*) **Sugar**—(α) *Moore's Test* (*Boiling with Liquor Potassæ*).—Add to the suspected urine an equal quantity of liquor potassæ, and boil in a test-tube. If sugar (more than 1½ gr. per ounce) be present, the mixture will be darkened and afterwards turned of a reddish-brown colour. This is an easy though rough method, but is open to fallacy in high-coloured and in albuminous urines, and where the liquor potassæ becomes vitiated by the presence of lead from the glass bottles, as in these cases a darkening, independent of sugar, will occur.

(β) *By the Reduction of Oxide of Copper* (*with Fehling's Solution*).—According to Roberts, this is the best method of detecting sugar in urine. It is described by him as follows:—"Pour some of the prepared test-liquor into a narrow test-tube to the depth of three-quarters of an inch; heat until it begins to boil; then add two or three drops of the suspected urine. If sugar be abundant, a thick yellowish opacity and deposit of yellow suboxide are produced, and this changes into a brick-red at once if the blue colour of the test remain dominant. If no such reaction ensue, go on adding the urine until a bulk nearly equal to the test employed has been poured in; heat again to ebullition; and, no change occurring,

set aside without further boiling. If no milkiness is produced as the mixture cools, the urine may be confidently pronounced free from sugar, for no quantity above a fortieth of a grain can escape such a search, and any quantity below that is devoid of clinical significance."

(*c.*) **Bile.**—A test for bile is equivalent to a test for bile-pigments.

Test for Bile-pigments.—Place a few drops of urine on a white porcelain plate, and near it lay a few drops of nitric acid. Bring the two fluids in contact by inclining the plate, and if bile be present, a play of colours will appear violet, green, red, which rapidly passes away.

The Test for Bile Acids is less certain, and may be omitted.

(*d.*) **Pus** and **Mucus.**—Take any of the doubtful sediment, and treat with concentrated caustic potash; pus will become a tough muco-gelatinous mass, while mucus will be changed into a thin flocculent fluid.

Examination of Deposits. — Before minutely examining any urinary deposit with the microscope, its "naked eye" characters should be carefully noted, as they alone are often distinctive. When the deposit after standing is small, and yet where its microscopic examination is important, the clear urine at the top of such a jar should be decanted off, and the remainder poured into a conical glass. After a second decanting, some of the subsequent deposit may be removed with a pipette, and placed on a glass slide under a cover-glass. Sir Henry Thomson advocates the simple expedient of allowing the urine to stand in a corked bottle placed with the cork downwards. The deposit which afterwards adheres to the cork can be easily examined.

For descriptive purposes deposits may be divided into two groups—

I. *Unorganised Substances* (soluble in moderately strong solutions of either acids or alkalies). Such as amorphous urates or phosphates, crystals of uric and oxalic acids, or of triple phosphate, and, rarely, cystine.

II. *Organised Substances* (more or less altered by weak acids or especially alkalies, but not dissolved by them).—Such as epithelial cells, pus, blood, or mucus, spermatozoa, tube-casts, micro-organisms, and foreign particles, which have obtained access to the urine.

For the examination of all these deposits, magnifying powers of 50 and 350 will be found sufficient.

I. **Unorganised Substances.**—A. *In an Acid Urine.*—(1) *Urates* form a loose deposit mingled with mucus, varying from a brick-red to a dirty yellow colour. They are distinguished from all other deposits (α) by being completely soluble by heat, (β) by forming a film on both the surface of urine and on the sides of the vessel in which the urine has cooled (*Roberts*). They may be combined with other deposits. Under the microscope they are amorphous and granular.

(2) *Uric Acid.*—Insoluble in dilute acids, soluble in caustic alkalies, in weak solutions of carbonate of lithia, potash, or soda, and

in solutions of borax and common phosphate of soda. May form a film on the surface, sink as a dense red deposit to the bottom, or appear as reddish granules on the sides and at the bottom of the vessel. Under the microscope the crystalline forms are numerous, but referable to combinations or modifications of a lozenge shape, or of a rhombic prism (Fig. 178, *a*, *b*, and *c*). Uric acid in the urine

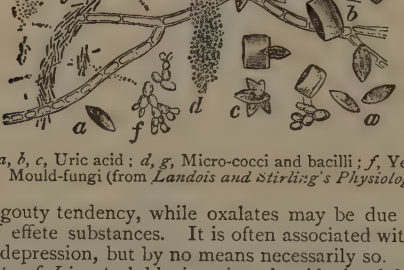


Fig. 178.—*a*, *b*, *c*, Uric acid; *d*, *g*, Micro-cocci and bacilli; *f*, Yeast-fungi; *g*, *e*, Mould-fungi (from *Landois and Stirling's Physiology*).

indicates a gouty tendency, while oxalates may be due to deficient oxidation of effete substances. It is often associated with dyspepsia and mental depression, but by no means necessarily so.

(3) *Oxalate of Lime* (soluble in mineral acids, insoluble in water or vegetable acids) forms a characteristic deposit to the naked eye, *i.e.*, lines on the side of the glass, due to crystallisation along the inequalities left after towelling; these differ from similar ones formed sometimes by uric acid in being finer and in being colourless; also a sediment with the following features:—An upper layer, white, hummocky, and sharply defined above; and a lower layer, softer and gelatinous in appearance, and greyish in colour. It is found in an acid urine, and is often associated with uric acid and amorphous urates. Microscopically, it shows a crystalline form, referable to combinations of four-sided prisms (Fig. 179, *a* and *b*), and a dumb-bell form (Fig. 179, *d*), supposed to occur when the crystallising process is interfered with by excess of mucus or otherwise.

B. *In an Alkaline Urine.*—(4) *Ammonio-magnesian* or *triple phosphate* is most frequently associated with decomposition of urine, either within the body as in some cases of cystitis, or out of it, as the invariable result of exposure to the organisms of the air. In the former case, the turbidity and deposit due to altered pus will be the most striking naked eye feature; in the latter it will be the turbidity—scum and deposit—due to the fermentation.

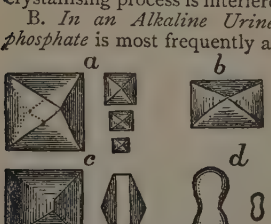


Fig. 179.—Oxalate of lime. *a*, *b*, Octahedra; *c*, Compound forms; *d*, Dumb-bells (from *Landois and Stirling's Physiology*).

When deposited by itself, the triple phosphate has a snow-white appearance, with bright sparkling crystals on

the sides of the glass, and forming a film on the surface (*Roberts*). Most frequently, however, it is associated with a deposit of amorphous phosphate of lime.

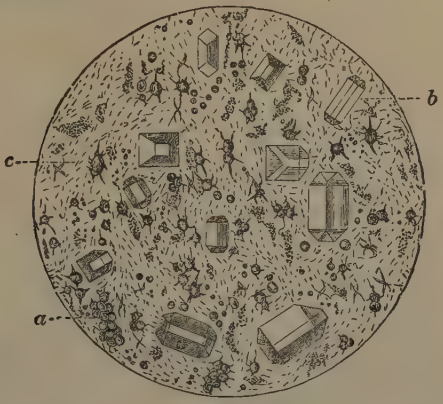


Fig. 180.—Deposit in ammoniacal urine (alkaline fermentation). *a*. Acid ammonium urate; *b*. Ammonio-magnesium phosphate; *c*. Bacterium ureæ (from *Landois and Stirling's Physiology*).

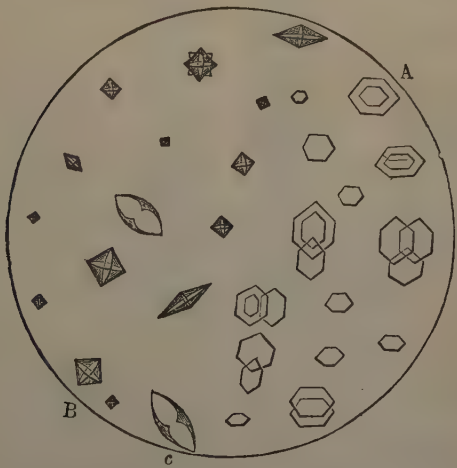


Fig. 181.—A. Crystals of Cystin; B. Oxalate of lime; *c*. Hour-glass forms of B (from *Landois and Stirling's Physiology*).

Under the microscope, the crystals are seen to be relatively large, prismatic with bevelled ends, and having forms modified from this by the bevelling of the various sides and angles (Fig. 180, *b*).

Associated with the triple phosphate, there is generally a deposit of *amorphous phosphate of lime*, although it is often present alone, where fixed alkali produces the alkalinity. To the naked eye it forms a light flocculent deposit, paler than the supernatant urine, and often forming a film on the surface. It is increased by heat and dissolved in acids. In rare cases this substance is deposited in a crystalline form—stellar phosphate—and then, when in any quantity, is considered as usually associated with grave disorder in any part of the body (*Roberts*).

Rare forms of inorganic deposits are *cystine*, in hexagonal plates (Fig. 181, A), which forms occasionally the substance of a calculus; xanthine, a substance very like uric acid in its crystals and composition, also in rare cases forming a calculus; and leucin and tyrosin, bodies whose presence is associated with phosphorus poisoning and yellow atrophy of the liver.

II. Organic Deposits.—(1) *Epithelial Scales* and *Mucus* (taken together because the latter without the former would generally not

Fig. 182.—Blood cast; altered corpuscles lying near it.

Fig. 183.—Epithelial casts.

Fig. 184.—Finely granular casts.

(Figs. 182-184 from *Landois and Stirling's Physiology*).

be visible). The light flocculent deposit found in healthy urine consists of epithelial scales shed probably from all parts of the urinary tract, and held together by the mucus; in women, flattened scales from the vagina will probably be added. In men, especially after gonorrhœa, the epithelial deposit from the urethra and prostate

often appears as whitish flakes and shreds, which, although indicative of no serious derangement, may occasion much groundless alarm. The epithelium from the bladder, ureter, and pelvis of the kidney, is so like the irregular cells of cancer that no deduction can be safely drawn from its presence either for or against malignant disease. Renal epithelium, generally more or less altered, is often seen in the urine when the kidneys are diseased, and accompanies a deposit of tube-casts.

(2) *Tube-Casts* consist of either fibrinous or blood casts of the tubules, or of the more or less altered epithelial lining of the tubules, still holding together and shed as a whole.

The recognised varieties are, epithelial (Fig. 183), opaque granular (Fig. 184), transparent or waxy, fatty, and blood-casts (Fig. 182).

As several varieties may occur together in the same urine, conclusions must be cautiously drawn from the prevailing types, rather than from individual specimens, and only after repeated examination. With these precautions and with the patient's previous history in view, Roberts says that "the following conclusions are *generally* warranted:—(*a.*) Epithelial casts and blood-casts indicate a disease of recent origin. (*b.*) Transparent large waxy casts, mixed with dark granular casts, indicate a chronic disease. (*c.*) Epithelium and casts containing much fat, indicate fatty degeneration."

These tube-casts are generally present in albuminous urine, and take a long time to settle. Twelve hours should be allowed. The methods indicated before for collecting deposit should be adopted, and are specially necessary.

(3) *Pus Cells* can be recognised under the microscope in urine without much trouble. When in large quantity their presence may be inferred from the naked eye appearances alone.

(4) *Blood Corpuscles* are not quite so easily recognised, owing to their liability to alteration (Fig. 182.)

Their bi-concave character is very soon lost by imbibition in most urines. In some cases they are found shrunken. Where there is a doubt, they may be recognised by "the extreme tensity of their outline, the absence of visible cell-contents, and especially of a nucleus, and their feeble refractive power" (*Roberts*).

While in an acid urine both pus cells and blood-corpuscles remain visible for several days, in an alkaline urine they are rapidly dissolved and disappear.

(5) *Spermatozoa* are easily recognised by their characteristic tadpole appearance. They are physiologically present in the urine after connection or a nocturnal emission, but in certain cases, as the result of masturbation or excessive intercourse—more rarely, however, than is popularly believed—they may be seen after straining at stool or at the end of micturition. The whitish fluid passed in many of the cases of so-called spermatorrhœa has been found to be more often prostatic than seminal. Contrary to the statement of many quacks who practise upon the bad consciences of their dupes, spermatozoa are very easily recognised in urine, even after it has begun to decompose, and are little liable to be confused with anything else.

(6) *Micro-Organisms* in urine are frequently found, and may be divided into three groups: (*a.*) Those which get access to the urine after it has left the body—*i.e.*, torulæ sarcina, and various forms of bacteria. (*b.*) Those which have gained access to the urine after it has left the kidney, but while still within the body—*i.e.*, the bacterium associated with ammoniacal decomposition. (*c.*) Those which are excreted as foreign matter by the kidney from the blood. In this group are numerous forms, frequently micrococci, associated with septic conditions and various zymotic diseases.

(7) *Parasites.*—Of these the one most likely to prove of surgical interest is the ovum of the bilharzia hæmatobia, associated with hæmaturia, of three kinds.

(*a.*) A few drops of blood at the end of micturition. When the parasite lodges in the prostatic part of the urethra (most frequent).

(*b.*) Whole of urine bloody. Parasite in bladder (or higher in urinary tract).

(*c.*) Blood always flowing. Parasite low down in urethra.

(8) *Foreign Particles* which have gained access to the urine after it has been passed, such are particles of flax, cotton, hair, wool, wood, or feathers, the source of which it is easy to trace.

CHAPTER XXV.

THE SYPHON AND ITS USES.

Contents.—Principle and Description of the Syphon and Water-head Apparatus in Surgical Treatment—Various Applications—Douches, Vaginal, Nasal, &c.—Syringing the Ear—Washing out the Stomach and Bladder—Thread-Syphons—Tying in a Catheter.

THE object of the syphon or other apparatus on the water-head principle in surgical treatment, is to obtain a continuous stream of fluid, and the ways in which they may be utilised are almost endless.

Description of the Apparatus.—(1) A **Syphon** is an inverted **U**-shaped tube, with one arm longer than the other. Both being filled—if the short arm be placed in a jug of water, with the long end allowed to hang over the edge of the basin, the water will flow out of the end of the longer arm with a force proportionate to the distance between its lower end and the level of the water. An india-rubber tube, 5 or 6 feet in length, will serve all purposes. It should be weighted at one end to keep it under water, and may be provided with a curved metal tube to prevent it from "kinking" as it comes over the edge of the vessel. A thicker piece of rubber tube slipped over it at the bend (*Foulis*), or a piece of sheet lead wound spirally round it there, will serve the same purpose. If need be, when ready, it may be tied to the handle of the vessel. To start the

syphon (*a*), sink the greater part of the tube below the surface of the water, which then, of course, fills it. Compress part of the long arm firmly, and while still holding it tight, bring it quickly over the edge and below the level of the water in the vessel; now let go, and the water will flow down. Pinch the long arm till the syphon is wanted. (*b*) Suck the fluid into the tube with a syringe.

(2) A modification of this is made by substituting cotton or worsted threads for the tubes. If the thread be wet, one end dipped in a basin or jug and the longer end brought over the edge, fluid will drop from the longer end exactly as if it were a syphon tube.

(3) The difference between the "syphon" and the "**water-head**" principle is, that the latter requires a vessel with an outlet pipe below. Instrument-makers supply special vessels for the purpose, with stop-cocks and gauges. Dr. Foulis has recommended as a cheap substitute a common tin-handled mug, large size, into the side of which, near the bottom, a stop-cock has been soldered. When the vessel is raised, the fluid it contains will flow out by the tube.

Fig. 185.—The Nasal Douche.

Modes of Using the Apparatus. — Either a "syphon" or "water-head" apparatus may be used:—

(1) Instead of a syringe for irrigating wounds or abscess cavities, or for washing out the mouth (after operations), the nose ("nasal douche"), the ear ("syringing the ear"), or the vagina ("vaginal douche").

Nasal Douche, though possible with a syringe, can be best applied with a continuous stream from a syphon or water-head of about a foot's pressure. The perforated terminal nozzle should be large enough to completely plug the nostril.

The patient, who must lean over a basin, should be instructed to keep his mouth open and breathe through it, while he raises the soft palate so as to enable the fluid entering by the one nostril to flow round the upper part of the pharynx and leave by the other (Fig. 185). Warm ¾ per cent., saline solution answers very well, or a weak antiseptic.

In Syringing the Ear the pinna should be drawn steadily upwards and backwards while the stream of warm fluid is directed along the roof of the canal. A funnel fitted to the ear should guide the returning fluid into a basin. Care must be taken not to force a strong stream against the membrane, lest it be ruptured.

(2) When provided with a suitable nozzle, as an efficient form of *enema apparatus*.

(3) *For washing out the Stomach or Bladder* when it is desirable to withdraw the fluid introduced into the cavity. This can be easily attained by introducing a side pipe near the entrance to the cavity (coupling on a short glass or other T-tube answers well). The fluid from the cavity can then be either allowed to escape by opening the side pipe (the supply pipe being closed for the time), or it may be withdrawn by syphon action by attaching to the side pipe a tube which reaches lower than the fluid in the cavity. By alternately opening and closing the entrance and exit tubes when once filled, as desired the cavity can be alternately filled or emptied. Of course, one tube may be made to fill and empty the cavity by alternately raising and depressing its end. This is simpler, but is less convenient, than the other method (see also p. 8).

The Thread-Syphons are chiefly used to *irrigate wounds* by moistening a cloth kept over their surface. A bottle containing the irrigating fluid (water or antiseptic lotion) is fixed to a cage over the wound. The amount of irrigating fluid is regulated as above. Below the limb, a mackintosh must be placed to catch superfluous lotion.

J. Duncan has also utilised this thread-syphon to withdraw from a urinary fistula urine which had previously escaped over the patient's skin and had caused great irritation with threatening bed-sores. He inserted wetted worsted threads inside a piece of india-rubber tubing; one end was passed into the wound, the other was carried over the edge of the bed into a basin of lotion. The threads carried every drop of urine into the basin below, and a certain amount of pus also; but as this partly clogged them, they had to be changed every day.

Tying a Catheter into the Bladder.—In almost all cases it is for the male bladder that this operation is required.

The conditions rendering such a procedure necessary are various—such as to produce "vital" dilatation of a stricture to establish the urethral channel after perinæal section, or to drain the bladder. In the latter case it is not advisable to keep the same catheter in for more than three or four days at the outside, nor to maintain the drainage for much more than a week at a time. For stricture twelve hours, or after perinæal section forty-eight hours, is generally long enough.

To minimise irritation, a soft instrument (soft rubber or gum-elastic) should be chosen, if it can be passed into the bladder. The instrument, when there is difficulty in passing it, may be made temporarily rigid by the insertion of a bougie which fits its calibre. After the bladder has been reached, the bougie may be withdrawn. The eye of the catheter should be just within the bladder—*i.e.*, just at the point where urine begins to flow when the instrument is pushed in. Unless means were taken to secure it, the catheter would very soon be forced out of the bladder. Moreover, a soft instrument, unless fastened to the penis itself, must be kept rigid with a stilette as far as the bulb of the urethra, otherwise, though fixed beyond the meatus, it is apt to double on itself and come out. The stilette of a gum-elastic catheter, if cut to the requisite length, and wrapped with

silk at its upper end, may be made to act as a plug and as a stiffener at the same time. A soft rubber catheter may be transfixed with a safety-pin, to the ends of which fixing threads may be attached, while to a gum-elastic catheter loops of wire or silk may be made fast for a similar purpose.

These fixing threads must in turn be themselves made fast, and many ways of so doing have been advocated. Sir Henry Thomson advises that they should be looped round the penis, and finally tied to a bundle of pubic hairs on each side. This is easily done.

Others fix them to the penis with sticking plaster.

A more usual method may be described as follows (Fig. 186):—

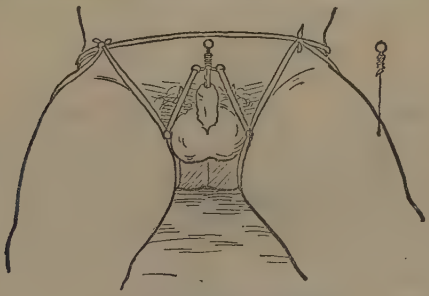


Fig. 186.—Tying in a Catheter.

To a waist-band passing between the trochanters and iliac crests are fixed in front two thigh loops; and to these *opposite the middle of the scrotum* are firmly knotted the threads which are fixed to the catheter. Unless the catheter threads are knotted to the thigh loops *well back*, the instrument will slide forwards out of the penis.

CHAPTER XXVI.

TRUSSES AND ARTIFICIAL LIMBS.

Contents.—**A. Trusses**—Various Forms—For Adults—For Children. **B. Artificial Limbs**—"Bearing" Points after Amputation—Sites for Amputation most suitable for the adaptation of Artificial Substitutes—Artificial Limbs, their Nature and Mechanism—General Hints.

A. Trusses.

(*a.*) **For Adults.**—A very great number of patterns of truss and of truss-pads have been introduced. In the great majority of femoral or inguinal herniæ, however, satisfactory results may be obtained with one or other of *two* forms of spring and pad.

(1) The "spiral spring," single or double.
(2) The "Salmon and Ody," or opposite-sided truss.

(1) *The Single Spiral Truss.*—In this, the spring has the spiral part chiefly near the pad; the spring encircles two-thirds of the body below the iliac crests, leaving out the front of the abdomen, where a strap unites the two ends. A perinæal strap to keep the apparatus down may be used, but is seldom necessary.

The *pad* is usually of horse-hair, covered with leather. Cole's pad is borne on a coiled spiral spring fixed to the end of the truss spring; others have advocated pads of solid india-rubber, or made in the form of bags containing air, water, or glycerine.

The *form* of the pad with the spiral truss is generally pyriform, with the broad part below. A horse-shoe shape is sometimes employed for an inguinal hernia, especially with a partly descended testis. For large scrotal herniæ, the pad is sometimes prolonged downwards.

For a femoral hernia the pad comes further down than it does for an inguinal hernia.

The *direction* of the pad's pressure for an inguinal hernia is obliquely upwards, backwards, and outwards, and nearly directly backwards for a femoral hernia; the pad in the latter case coming nearly vertically downwards from the end of the spring, instead of obliquely downwards and inwards as in the former case.

In a *double spiral truss*, both ends of the spring end in a pad. Double trusses are to be used—not only where there is a double hernia, but where with a single hernia the canal of the opposite side is weak. In such cases of two possible evils—viz., opening up of a weak canal by descent of intestine, and absorption of parts by the pressure of the truss—we consider the latter to be the less.

(2) *The Salmon and Ody Truss* (single), has a pad behind at the spine as well as one in front. It is also called the "opposite-sided" truss, because its spring passes from the spine round the front of the body on the side opposite to the hernia, and thus crosses the middle line in front to reach the hernia. This gives it great security. It is chiefly used for femoral hernia, though it may be applied for inguinal hernia also.

The *pad* is usually circular in shape, fixed to the spring by a ball and socket joint. A perinæal strap is generally worn.

A *double* Salmon and Ody truss has a double pad behind, with the spring passing round each side to end in a pad on its own side. It is thus, when double, not an opposite-sided truss.

In fitting a truss for inguinal or femoral hernia, the instrument-maker must see that no pressure is borne on the pubes. In inguinal hernia, the pressure must be mainly at the internal ring and along the canal; in femoral hernia, it must be vertically backwards on the femoral canal.

The truss should be worn constantly by day, and by night also—if the patient be subject to coughing. During temporary removal, the patient should be in the horizontal position, and the vertical position of the trunk should not be resumed without the truss.

A bathing truss (covered with waterproof) should be worn in the bath. Some surgeons hold that the truss should never be removed, day nor night.

Umbilical herniæ must be treated with a spring truss and a flat pad.

For Children.—In children, trusses similar to those used for adults are generally indicated. For umbilical herniæ the spring may be replaced by a belt.

In male infants the form of hernia almost exclusively met with is the inguinal. If the skin will not bear the pressure of a pad with the ordinary spiral truss, a pad of wool kept in place, with the looped (p. 112) or a spica bandage (plain or elastic) will often suffice; or the worsted truss re-advocated by Lund (*Hunterian Lectures*, 1885) should be employed. A skein of Berlin worsted, 22 inches long, and consisting of 20 threads, is passed round the child's waist (Fig. 187). The end passing round the side opposite from the hernia is held at the seat of the hernia, while the other end is passed through it, and after encircling the thigh is fixed with tapes or a safety-pin to the waist part. Two such trusses may be kept in use, each being washed alternately. Umbilical hernia in infants, when not very bad, is best treated by two strips of plaster crossing at the umbilicus, and drawing the abdominal walls together at that point.

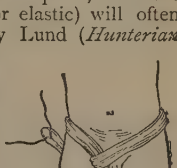


Fig. 187.—Skein of Worsted Truss for Infants.

For *irreducible hernia* in any region, where an operation is not indicated, Bryant recommends a hollow metal pad lined with wash-leather, and made to fit exactly by being moulded over a cast of the hernial protrusion.

B. Artificial Limbs.

The subject is important, not only because certain stumps are said to be better suited than others for artificial limbs, but also because a surgeon should at least be able to advise his patients as to the form of artificial limb available for their particular case and circumstances.

We shall accordingly consider the following heads:—(1) The "bearing" points in the lower limb after amputation. (2) The sites for amputation in the upper and lower limbs most suitable for the adaptation of artificial substitutes. (3) The nature and mechanism of artificial limbs. (4) General hints on the use of artificial limbs.

(1) **"Bearing" Points—After Amputation.**—As might have been expected, the best "bearing" points are the natural ones; at the heel first, then that on the bent knee. Thus, in a favourable case, after Hey's or Chopart's amputation (and there is no reason why, as a general rule, cases should *not* be favourable), the patient walks on the heel, and on what remains of the sole, without trouble. Also, in amputation just below the knee, the joint may be kept bent, and the patient can then *generally* bear his full weight upon it, although with the risk of developing a "housemaid's knee."

After these come amputations in which the skin of the heel and that of the front of the knee, respectively, are folded over the sawn surface of the corresponding articular end of the adjacent bone. Thus, in most, but not in all, of Syme's amputations, the full weight can be borne on the face of the stump. In a Carden's or Gritti's a certain but variable amount of the weight only can be borne.

Next in order of "bearing" power would come amputations through the same articular ends of the femur or tibia, but where the covering skin had, from the nature of the case, to be taken from the lateral or flexor aspects of the limb. When the shaft, instead of the (lower) articular end of the femur or tibia, is sawn through, little, if any, bearing can ever be taken on the resulting stump, however favourable in other respects the amputation may be. Fortunately, however, the instrument-maker has other points of bearing to depend on besides the face or end of the stump. *Below* the knee a considerable part, if not the whole, of the patient's weight can often be borne on the upper ends of the tibia and fibula. *Above* the knee a considerable proportion can be borne on the muscles of the thigh by means of a lacing shield, and there are few cases where, if need be, the whole weight cannot be borne on the tuber-ischii and trochanter, by the adjustment of a padded ring like that used for Thomas's knee-splint (p. 189). The lower in the limb the bearing can be taken, the greater the advantage to the patient in walking. The instrument-maker requires to adapt his points of bearing to the particular case, sometimes distributing the weight over several parts, sometimes confining it to one.

(2) **Sites for Amputation.**—(*a.*) *In the upper limb* there is no question that above the fingers (see p. 92) the greater the length of the natural parts left—other things being equal—the better for the patient in every way. Artificial parts, more or less efficient, can always be adapted to the stumps. The surgeon's way is, therefore, clear—he must leave as much as he can.

(*b.*) As regards *the lower limb* there is much greater difference of opinion. Some instrument-makers go so far as to say that a jump is to be made from the ball of the toes to the level of a Syme or Pirogoff, and that if 4 inches below the knee cannot be left to allow of a strong control of the artificial limb by the stump, the surgeon should amputate 4 inches above the knee to give room for the mechanism of an artificial knee-joint. From these views we entirely dissent.* After a careful examination of the whole subject, our conclusion is that the surgeon should take "the least sacrifice of parts" as his guide, and amputate as low as the circumstances of the case permit. He should spare as much bone as he can, and he may be satisfied that artificial limbs can be made for the stumps. The longer the limb left, the better the walking power.

(3) **Artificial Limbs.**—We cannot, of course, attempt more here than a discussion of general principles :—

(*a.*) *For Partial Amputations of the Foot* (Hey's or Chopart's),

* See *Ed. Medical Journal*, March, 1888, and 1889.

if during healing of the wound care be taken to bandage the stump well and keep the knee flexed, section of the tendo Achillis is seldom necessary. When the stump has healed, the patient bears his weight on what remains of the sole of the foot. At first there may be aching and weakness as the arch of the foot sinks down. Afterwards there will be no further trouble, and the only artificial limb required is a stiff-soled boot, lacing well above the ankle, and having cork or other stuffing to fill the place of the parts of the foot which have been lost.

For a Syme's or Pirogoff's amputation, a cheap and useful, though not ornamental, artificial limb consists of a bucket ending in a rounded leather end, sufficiently long to equalise the two limbs, and taking its bearing either on the face of the stump or at some of the points, before mentioned, above it. When an artificial foot is desired, the axis of movement of the artificial ankle should not be below the level of the stump, as it is usually made, but is more naturally placed slightly above it. Moreover, and what is of greater importance, the face of the stump should rest not on the foot—but on the leg-portion of the artificial limb, which should then be jointed to the foot-part. If this is done, the face of the stump has weight to bear, but has no friction. By the usual method—where the stump rests on the foot-piece—friction on the face of the stump is inevitable, and probably explains why so many otherwise good stumps are comparatively useless for the "bearing" of an artificial limb.

(*b.*) *Artificial Ankle- and Foot-Joints.*—Of these there are no end. The first point to understand is—What can an artificial ankle- and foot-joint *not* do, that a natural one does? Next, what may it be expected to do?

A minute's reflection will make it plain that no artificial joint can imitate active muscular contraction—*e.g.*, forcible extension of the foot as in rising on the toes, and that the active balancing lateral movements of the foot can never be replaced if the natural mechanism be lost. What can an artificial foot and ankle then do? It can imitate the appearance and *some* of the movements of the original, and permit of a more or less halting gait. Marey, in his analysis of the human step in walking, has shown that the trajectory of the knee of the supporting leg is nearly in a straight line—*i.e.*, that the knee joint neither rises nor falls as the leg passes from the position directed obliquely backward (as the heel comes down), through the vertical, to that sloping obliquely forwards as the toe leaves the ground. Owing to the active muscular changes at the ankle-joint, this is attained with a longer stride than would be otherwise possible. Without such an actively changing ankle and foot, the stride must be less, but the same straight-line-trajectory of the knee can be obtained by ensuring that the leg from the knee downwards rolls forward on a sole, curved in the arc of a circle whose centre is at the knee-joint, and whose radius is equal to the distance between the knee and the sole of the boot. This produces the same effect as if the knee were the axle of a wheel and the sole of the foot part of the circumference. This curve of sole is

practically that empirically advocated by Count Beaufort in his cheap limbs for the working classes. The effect of this close imitation of nature explains why it is that, in amputations below the knee, the gait of the patient with a Beaufort limb is so good, equal to, if not better than, that attained by a patient with the most expensive limb ever made. While this form of curved sole gives such good results and is so simple, two secondary objections may be raised against it:—(1) That it is awkward in appearance. (2) That it does not yield laterally so as to accommodate itself to a side slope. To obviate the first objection, when desired a spring might be arranged so as to flatten down the fore part of the foot when not actually pressed upon, and the second may be met by allowing a slight lateral play in the foot controlled by strong springs. These objects are not necessary, however, and besides increasing expense might introduce a source of weakness into the limb. Whatever else instrument-makers may do to obtain an appearance, they should ensure that the trajectory of the knee is in a straight line as the foot rolls forward. However, an artificial foot which pivots at the ankle, or on the balls of the artificial toes, must make the knee pass through the arc of a circle, and not continue in the desired straight line. A slight amount of lateral play in the *foot* may be permitted if desired.

When a stump ends shortly above the level of any joint, the new joint may be in the form of a transverse rod working in a socket (hinge joint). When the stump comes below the level of the new joint, the axis must be made to work on two* "rule" joints, one on either side of the stump. This form of joint is said to be less lasting than the other, but is very often unavoidable.

(*c.*) *Artificial Knee.*—According to circumstances, a rule or a hinge-joint may be employed; but, to avoid friction, the bearing must always be taken on the upper of the two pieces forming the joint (see p. 235). When the artificial limb is straightened, the line of downward strain should pass in front of the axis of the knee-joint, which should then be locked so that it cannot over-extend. This imitation of nature permits the patient to bear full weight on the straight knee without any fear of its giving way. The knee will bend easily enough as the thigh flexes to lift the leg off the ground, and the swing forward will again straighten the knee for the next step. In some cases a slight straightening spring is needed. By the artificial tendo Achillis mechanism with appropriate springs, the artificial knee- and ankle-joints are always extended and always flexed together. The latter combination is useful in clearing the ground as the leg is carried forwards for a fresh step, but the double extension makes the lower limb, when supporting, pivot forwards on the fore part of the foot, and this, as we have already seen, is a disadvantage to the gait.

For cheap limbs, the knee is kept rigid while the patient walks; but in most it is made to bend by the relaxation of a spring for convenience when the patient sits down.

* Like the joint of a foot-rule.

On these general principles it is not difficult to see how efficient and yet cheap limbs may be constructed, of which the Beaufort limbs may be taken as the type. The old-fashioned bucket and pin legs, and kneeling legs will, it is hoped, soon be replaced by as cheap but more efficient substitutes.

(*d.*) *Artificial Arms.*—Many expensive patterns are in vogue, but for cheapness and efficiency the Beaufort arm is the best. This, below the elbow, consists of a closed hand with movable thumb closing with a spring, which is opened out as the arm is moved from the side. When an object is to be grasped, the arm is moved away from the side, and the opened thumb is made to surround the object. If the body be now brought up to the arm, the spring is allowed to close the thumb, and so to secure the object.

For amputations above the elbow, besides this thumb-movement, an elbow-joint is provided, which can be either kept extended or firmly locked at a right angle, as required.

(4) **General Hints.**—As stumps are apt to atrophy at first from disuse, then to regain something as they are put to a modified use, the wearers of artificial limbs must be cautioned that alterations in the new limb and its padding will be needed to correspond to those changes.

It is better not to allow a patient to use crutches, or an inferior form of artificial limb at first, lest bad habits of walking should be learned which cannot be afterwards broken off without great trouble.

CHAPTER XXVII.

PLASTER-CASTING.

Contents.—Use of Plaster-Casting to the Surgeon—How to prepare the Plaster—How to take the Mould—How to make the Cast—How to remove the Cast from the Mould—Casting in Gelatine and Glycerine.

PLASTER-CASTING is often useful to obtain a permanent record of abnormalities, and as a means of enabling instrument-makers at a distance to fit apparatus accurately.

The stages of casting may be divided into—(1) Mixing the plaster; (2) taking the mould; (3) making the cast.

(1) *Mixing the Plaster.*—The plaster of Paris used is of good medium quality, about 9d. a stone; not the extra fine kind used by dentists, nor the coarser sort for rough castings. It should be thoroughly dry, and can be baked in an oven, or by the side of the fire, if at all damp. Take, in any common bowl, half as much water as is required of the mixed plaster (warm water causes more rapid

setting than cold; and in winter the chill should be taken off the water for the patient's comfort, when the cast is from the living person), sprinkle lightly into the water—*without stirring*—spoonful after spoonful of the dry plaster until it rises up through the water, and shows just beneath the surface all over. There is now enough. Stir the whole rapidly, working it up from below and from the sides. When mixed, it is ready, and, although quite fluid at first, soon becomes thick. It will be found that nearly an equal bulk of plaster and water are used, and that the mixture is only a little less than twice the bulk of water taken.

When a *plaster-cast* is to be taken from the mould, ink or some other colouring-matter should be added to the plaster for the mould as it is being mixed. The reason for this will be afterwards explained.

(2) *Taking the Mould.*—If the amount of surface to be cast is such that it can be pulled out of a one-piece mould, the process is so much the simpler. Although the pliable soft textures can be withdrawn from a plaster mould, which partly surrounds them, the extent to which this can be done will vary with the part, and must be learned by practice. A plaster-cast and mould, on the other hand, being both rigid, can only be separated when, besides not sticking, they do not enclose one another.

Suppose the back of a man's hand is to be cast. Shave off all hairs from the dorsum of hand and first phalanges—the soft hairs on a woman's or child's hand may be smoothed down with soap and vaseline—next lay the hand, fingers and thumb together, prone on a board spread with a piece of paper. Partly fill up the hollow under the wrist to prevent the plaster from getting too far round. See that the hand is well smeared with oil or vaseline. Mix sufficient plaster of Paris to cover the hand all over with a half-inch thick layer. When first made, the plaster will be too thin to lie on the hand; very soon, however, it will become like cream. In this state lay it over every part of the back of the hand and fingers, and, as it thickens, plaster it on more and more. Care must be taken to see that every part is uniformly covered; there is a risk that some parts will be as thin as egg-shell and break very easily, while others have more than their share. When every part is satisfactorily covered, leave the plaster for five or ten minutes to set. This process will be indicated by its growing distinctly, though not uncomfortably, warm. Before the mould is ready to lift, any small projection, when tested, should crack off as a whole, and not crumble under the finger. When sufficiently hard, it should be cautiously lifted from the hand.

When both sides of an object (say, the hand) are required, the mould must be taken off in two pieces. There are many ways of doing this, but the "thread" plan is perhaps the best.

Mix plaster as before, but in two portions, one after the other—one is to be laid down first as a bed—and when it is thickening and can be heaped up into a level layer, the hand is allowed to sink a very little way into it. Next make a fresh quantity of plaster, and as it thickens take a piece of strong pack-thread or thin twine, and

by means of the plaster make it stick to the skin all round the most prominent part of the hand, and at the tips of the fingers if extended. Now, rapidly cover over the whole of the rest of the hand as before. The thread will remain in its position, unless disturbed. When the plaster has thickened to the consistence of cream-cheese, draw the thread steadily out through it all round. If the right state of the plaster has been chosen, the track of the thread should remain open. Should the plaster be too soft, it will fall in on the thread's track; should it be too firm, it will crack and break rather than let the thread come through. Do not touch the mould otherwise until it has set. By cautiously inserting a knife into the track of the thread at various parts, the top of the mould may be lifted off, and the hand withdrawn from the lower half.

The *foot* is a little more difficult to manage. Two threads must be taken whose tracks overlap, and each of which must be drawn out only until it meets the track of the other. One loop of thread passes below the sole and up the leg over the malleoli, the ends being held at first above and parallel with the axis of the leg. The other parallel with the long axis of the foot passes round the back of the heel, and coming round the sides of the foot at its most prominent part, crosses in front of the great toe, where the ends hang forward. Having covered the foot with plaster, the caster must heap up the plaster on the ankle and lower part of the leg while it is soft enough to mould itself to the skin, yet firm enough not to run down when placed in position. The threads are to be drawn out as before—in this case from above, and from the front until their tracks cross, below the malleoli. The two pieces of the mould thus mapped out are, one covering the front of the leg and dorsum of the foot, and the other covering the back of the leg and sole of the foot.

(3) *Making the Cast.*—The chief points requiring attention are, how to prevent the cast from sticking to the mould, and how to obviate air bubbles in the cast. Freshly-made plaster, if poured into a mould which has not been specially prepared, will assuredly stick to it. The simplest and best way to prepare the mould is to soak it in water for an hour or two before it is needed. To test for sufficient soaking, watch, after the mould is taken from the basin, whether water remains on the plaster, or dries in. If the latter, the pores of the plaster are evidently not yet filled with water, and further soaking is needed. If the mould be quite soaked, the fresh plaster will lie in the most perfect contact with every detail of its surface without uniting to it. In addition to thorough wetting, the surface may be painted over with olive oil or be dashed over with soap-suds, and then again with pure water (olive oil painted over the surface of a dry mould is almost at once sucked in and becomes useless, unless by many repeated coats the plaster is filled with it. Boiled linseed oil after two or three coats will form a varnish on the surface, but it is apt to impair the sharpness of the cast, unless care is taken to limit the amount).

The only way *to prevent air bubbles* from forming between the mould and the cast is to pour the plaster slowly and by instalments into the mould, and to keep constantly shaking and turning the mould round and round all the time. Sometimes it is an advantage to pour the fluid plaster into and out of the mould once or twice, in addition to turning it round and round. If plaster be poured in without these precautions, air-bells will certainly disfigure the cast. When the mould is nearly full, a loop of string should be pushed into the plaster to hang the cast by afterwards.

(4) *Removing the Cast from the Mould.*—Except in almost flat casts, this must be done at the expense of the mould. In all ordinary casts, only one copy can be made from the original mould. Additional copies can be taken from this by making either an elastic gelatine mould or a plaster "piece-mould."

The plaster-cast, which has been filled into the mould, should be set aside for twelve hours. With a chisel and hammer the mould must then be chipped away piece-meal, care being taken not to let the chisel cut into the cast. The advantage of staining the plaster of the mould will now be apparent. It will be found an advantage to begin at the edges, and special care must be taken of any projecting or thin piece of the cast lest it be broken off with the mould.

If the cast is to be painted, one or two coats of boiled linseed oil or of size, as a preliminary, will prevent the paint from being absorbed too quickly by the porous plaster.

(*a.*) *A Gelatine Mould* is made by suspending the cast, bone, or other object to be copied, in a wooden box large enough to give an interval of at least an inch between the object and all sides of the box. Into this is poured very strong gelatine, or glycerine and gelatine, while hot and fluid. When the mould is cold, the sides of the box are taken off, and a cut made in the gelatine all round, half way up the most prominent parts of the object. After lifting off the top half of the mould, the object can be pulled out of the lower half. The two halves should then be laid together, and a hole cut out of the upper one, opposite its highest point. The sides of the box are now replaced and bound in position, and, in addition, the top of the mould must be held down to prevent the plaster from escaping, leaving, of course, the top aperture free. A plaster-cast can then be run into this gelatine mould, which, from its flexibility, can be lifted off from the rigid cast without injuring it.

(*b.*) *A "Piece-Mould"* is made of plaster of Paris, and being rigid as well as the cast, must be made of many pieces, each of which can be lifted off without going round a corner. The object to be copied is first mapped out into areas where casts will lift off; the first area is banked round with clay, the second and succeeding pieces are ranged round the first—blank sides being banked up, and already made "pieces" being smeared with vaseline to prevent succeeding ones from sticking to them. When the whole is complete, the inner surface is covered with boiled linseed oil; and the pieces having been fitted together are bound with string, and the cast is made through a hole left for the purpose.

Casting in Gelatine and Glycerine is done as follows:—

(1) *Preparation of the Material.*—Take of "No. 1" gelatine (this is like strong clear glue), say 6 ozs. (by weight), soak it till quite soft and swollen, afterwards dry it slowly until just pliable. As it has now the minimum of water necessary, melt it in a water bath, and add 6 ozs. (measure) of clear glycerine (not necessarily purified). When the two are thoroughly mixed, the material is ready. To render it opaque, add, while it is still hot and therefore fluid, small quantities of a thick paint made by rubbing up oxide of zinc in glycerine. When a skin colour is wanted, a little vermilion is required to give a warm life-like hue. Should tumours or other objects be cast, the prevailing colour can be given with water-colour as required (tubes of moist water-colour sold at 2d. each will be found convenient). Several pounds of this mixture may be made at once. A cook is a good ally to have for the purpose.

(2) *Preparation of the Mould.*—From the part to be cast, a mould in plaster of Paris must be taken in the ordinary way. It will be found best to limit the casts to those whose moulds can be removed from the organ or living body in one piece. When both sides are moulded at once, the gelatine cast is by no means easy to extract from the mould. After the mould has been removed from the body, it must be slowly and thoroughly dried. If the mould be moist, the gelatine cast is softened; if too much heated, the plaster itself crumbles. Besides the thorough drying, no other preparation of the mould is needed, but for convenience the margins should be banked up with clay before the cast is made.

(3) *Making the Cast.*—Melt the gelatine and glycerine previously prepared, and pour it into the dried and banked up mould, being careful to roll the melted mixture backwards and forwards well over the face of the mould, so as to get rid of air bells. As the heated substance tends at first to run into the hollows and leave the raised parts of the mould with a very thin coating, the operator must keep ladling up from the hollows, and as the substance cools, it will become sufficiently tenacious to remain on the upper parts.

(4) *Making a Plaster Bed for the Cast.*—While the cast is still in position in the mould, its reverse side must be covered with lint or wool, and this in turn covered with plaster of Paris, either pure or mixed with cotton wadding, oakum, lint, wood-wool, &c. This must be made to fit into the hollows and elevations of the back of the cast, and when set it is to be removed so as to be dried. The cast, when cold, can be easily drawn, or rather peeled, out of the mould, and it will be found to be an elastic cast of what is wanted. When placed upon its plaster of Paris backing, it will preserve the shape which it had while in the mould.

(5) *To Paint the Cast as required.*—Use water-colours when a dry surface is to be imitated, oil-colours when the surface has to appear moist. The water-colour may require several coats. Finally, arrange an edging of black velveteen or other material to hide the irregular margins and give a finish.

N.B.—The advantages of this method of casting are its likeness in appearance and texture to flesh, and the great number of copies which may be taken from the same first mould. The disadvantages are, the possibility that it will not keep really good for more than eight or ten years, and the greater time required to make a cast in this than in plaster of Paris.

Price.—The cost of the materials amounts to about 1s. 6d. per lb. of the mixture.

CHAPTER XXVIII.

POST-MORTEM EXAMINATION.

Contents.—Preliminaries—Special Examination: the Head—Neck and Thorax—Heart and Lungs—Abdomen—Spinal Cord.

THE practitioner may be called upon to make a *post-mortem* examination, either in private or in a mortuary. In private practice it is well to be provided with a plentiful supply of newspapers, a couple of old sponges, mackintosh, cotton wadding, twine and one or two jars, in addition to the usual case of instruments.

Preliminaries.—It is always advisable to have an assistant to take notes as the examination proceeds. The body should be lifted from the coffin, and laid on a long table. The grave-clothes should be most carefully removed, and laid aside in due order, and the pins with which they were secured retained in position for re-insertion. The general appearance and state of nutrition, rigor mortis, and hypostatic congestion should be noted, and the length of the body and its thoracic circumference ascertained. Local peculiarities, such as œdema, birth marks, deformities, cicatrices, wounds, and the condition of the pupils should be described. Newspapers are now to be packed under and around the body. The part on which interest chiefly centres should be first examined.

Special Examination—The Head.—To reflect the scalp, the knife should be entered deeply behind the ear with the back directed towards the bone and the edge towards the skin. It is now firmly pressed against the skull-cap, and carried across the vertex to the opposite point. The two flaps thus formed are to be thrown well down, detachment being effected by means of the handle of the knife, aided by a few touches with the blade. The pericranium and attachments of the temporal muscles are now divided by sweeping the scalpel around the skull, about three-quarters of an inch above the upper angle of the orbit, and half-an-inch above the occipital protuberance behind. The saw is more easily managed if the table be low. It is advisable either to stand on the left side of the cadaver, and grasp the frontal flap with the left hand, or to stand on the right side, and steady the head with the left hand wrapped in a towel. The saw is now carried, at the marked out level, lightly through the *outer* table, except at the temporal ridges and occipital bone, where the *entire* thickness of the skull-cap should be divided, care being taken not to injure the dura mater or the brain. The chisel may now be inserted and detachment completed by means of a few smart strokes with a mallet; or by merely rotating the chisel in the saw-cut, the skull-cap may be prised off.

[*In Medico-legal Cases*, and where fracture of the cranium is suspected, the saw should divide the entire thickness of the bone everywhere, as the chisel is apt to make cracks and fissures. If the skull-cap

be firmly adherent, as in children, the dura mater must be carefully divided all round with a probe-pointed bistoury, and the anterior and posterior attachments of the falx severed.]

On removal of the calvarium, the tension and condition of the dura should be noted; the great longitudinal sinus slit up and examined; the anterior end of the falx cut; and the dura divided all round, so that it may be raised and its under surface studied.

The pia mater and cerebral surface may now be investigated, after which the brain has to be removed as in the dissecting-room, viz.:—by raising the frontal lobes, dividing the nerves *seriatim*, carefully cutting the tentorium along its attachment to the temporal bone, and severing the medulla and vertebral arteries as low as possible. The brain may now be laid aside in the skull-cap, while the base of the cranium is carefully examined, its sinuses opened, the dura stripped off in a search for fractures, and the condition of the middle ear ascertained.

Attention is now directed to the brain. The lateral ventricles may be laid open by horizontal slices from above downwards, and the basal ganglia exposed by transverse sections. The cerebellum is cut into vertical and transverse sections, but the nature of the examination must largely depend on the character of the special lesion.

Neck and Thorax—The viscera of the neck and trunk are reached by a mesial incision which extends from the chin onwards, by the left side of the umbilicus, to the pubes. By entering the peritoneal cavity at the ensiform cartilage, the fingers may be introduced and used as a director, so that the bowels are shielded while the abdomen is opened. The cage of the thorax is exposed by bold sweeps of the knife on the sternum and ribs. The sterno-clavicular articulations should be opened, the costal cartilages divided rather obliquely inwards close to the ribs, and the diaphragm separated below. We are thus able to throw the sternum and cartilages upwards, and to complete its disarticulation. The position and condition of the thoracic viscera may now be studied, and before they are handled we should also note the condition of the abdominal organs. The skin and pectorals should be tucked over the ends of the ribs, so that the hands are protected as they are introduced to explore the pleural cavities. The pericardium is now to be opened, and the heart examined *in situ*.

Heart and Lungs.—By following the course of the blood through the heart, we arrive at a conclusion as to the amount it contains, the state of its walls, valves, and cavities. The right auricle is opened by an incision, throwing the superior and inferior venæ cavæ into one. The right ventricle is next to be laid open by an incision immediately to the right of the septum; the left auricle by cutting from the entrance of the pulmonary veins downwards and forwards, in front of the appendix; the left ventricle by an incision along its anterior surface, immediately to the left of the septum. The heart may be now removed by dividing the great vessels, and the competency of the valves and state of the coronary arteries ascertained. The lungs may next be separated, and cut in section

from base to apex. If necessary, all the organs of the neck and chest may be removed *en masse*. This is done by dissecting back the skin of the neck, and then thrusting the knife through the floor of the mouth, so as to divide the mucous membrane close to the jaw all round. When this is done, the tongue may be pulled downwards and outwards, and as the larynx, trachea, œsophagus, and great vessels, are pulled forwards, they may be stripped from off the prevertebral muscles and cervical vertebræ. The vessels passing over the first rib are next divided, the contents of the posterior mediastinum, as far as may be, detached from the vertebræ, and the structures piercing the diaphragm cut; whereupon we may lift out everything – and examine the parts in detail. The larynx, trachea, bronchi, and œsophagus should be slit up.

The Abdomen.—An inspection having been made prior to removal of the thoracic viscera, the abdominal organs may be now more carefully examined, and, if necessary, removed. For this purpose, double ligatures should be applied to the cardiac and pyloric extremities of the stomach, the beginning of the jejunum and the sigmoid flexure. The bowel may be removed for complete examination by cutting between the ligatures and dividing the omentum and mesenteries. The stomach, liver, duodenum, and pancreas may now be removed together. The duodenum should be laid open, and the patency of the bile-passages ascertained by pressing upon the gall-bladder, and by introducing a probe-pointed knife and slitting them up. Sections may be made of the liver and pancreas, and the stomach opened. The kidneys, ureter, and bladder, together with the rectum and ovaries in the female, may now be removed. The size and consistence of the kidney should be noted, and also the thickness and adhesion of the capsule. It should then be laid in halves with a knife, the pelvis opened, the ureters followed up, and the bladder incised.

The Spinal Cord is reached by laying the body prone, and making a mesial incision from the ligamentum nuchæ to the sacrum. The arches of the vertebræ should now be exposed, divided with saw and chisel, and removed as in the dissecting-room.

At the conclusion of the autopsy the organs may be carefully replaced, and the incisions closed with a continuous suture. The body should be left exactly as found, the grave-clothes replaced, and the most scrupulous care exercised to avoid leaving even the trace of a stain. The operator's hands should be held from time to time in running water from a tap, if possible, or washed with turpentine and carbolic lotion.

APPENDIX.

A. The Microscopical Examination of Secretions and Discharges.

The microscopical examination of secretions and discharges has now become almost as much a matter of routine as the examination of the urine. The presence of organisms in wounds, blood, or pathological products, is of great significance and interest. An Abbé's condenser and high magnifying powers are to be employed. The fluid should be obtained fresh, and spread on very fine cover-glasses. It is obvious that cover-glasses and instruments must be absolutely pure. The glasses, if dirty, should be soaked in nitric acid, and may always be kept for use in strong acetic acid, from which they are removed and dried with a clean cloth before use. A drop of the discharge to be examined is lifted on the point of a needle—which has just been purified by heating to redness and spread in a fine film over the surface of the cover-glass. A couple of films may be obtained by placing a drop between two glasses and pulling them asunder. The film is then carefully and thoroughly dried by holding it for a little well above the lamp. Finally, just before staining, the cover-glass should be drawn thrice through the flame of a Bunsen burner at the rate of a long pendulum swing; this fixes the film, and makes it stain more readily.

Staining.—Place on the film for 60 seconds a drop of a 2 per cent. watery solution of methyl aniline violet, with 20 per cent. absolute alcohol added; wash off with a gentle stream of distilled water, and examine. In the case of blood, the stain should be a half-saturated alcoholic solution.

Gram's Method.—Prepare a watery solution of aniline oil by putting a drop or two of the oil into a test-tube, adding about half an ounce of water, and after shaking, filter. Add to this 11 per cent. of a saturated alcoholic solution of gentian or methyl violet.

Let the cover-glasses stain in this for 15 to 30 minutes. [Sections require twice as long.] Then *at once* place them in Gram's fluid—Iodine, 1 part; iodide of potassium, 2 parts; water, 300 parts; or as a substitute for this, add tincture or liniment of iodine to water, till of a dark-sherry colour. They should next be transferred to *absolute* alcohol, and then placed in a weak watery solution of Bismarck brown or eosine for the contrast stain, after which they should be washed in distilled water, laid to drain on blotting-paper, end on, and, before mounting, held about 1½ foot above the lamp to dry. A drop of Canada balsam dissolved in xylol serves for mounting.

The bacilli of tubercle may be stained after the manner of Gibbes, with whose reagents full instructions are supplied. The following method, a modification of Neelsen's, has also been recommended:—

Staining Solution

Fuchsine, 2 grammes, ...	=	2 per cent.
Absolute alcohol, 20 cub. cent., . .	=	20 ,,
Water, containing 5 per cent. of carbolic acid, 80 cub. cent., ...	=	80 ,,

Place some of the solution in a watch glass over a spirit-lamp, and float the cover-glasses, film downwards, on the stain. Heat gently, till steam rises, for 5 minutes. Place in 25 per cent. sulphuric acid for one second; transfer to absolute alcohol till decolorised. A contrast stain is now got by placing the cover-glasses in watery solution of methylene blue for half a minute, after which they must be washed in distilled water and mounted. The tubercle bacilli come out pink, and other organisms and structures blue.

B. Instruments and Appliances for various Operations.

Previous to an operation, and preferably the night before, it is well to lay out the necessary instruments and, in addition, others which are likely to be required, should any complications or emergency arise. If the steps of the operation be gone over *seriatim*, and each instrument selected as it would come into use, there is little chance of any omission. In the following lists, the requirements at the more common major operations have been mentioned; but in order to avoid repetition, the first two lists on Anæsthesia and General Requisites have been given separately, and must be added to each of the others. Immediately after use, the instruments must be carefully cleansed and dried, and again inspected before being put away.

I. **For Anæsthesia** (see page 12).—Chloroform, ether, hypodermic syringe, artery forceps (Fig. 18), towel or inhaler, cocaine.

II. **General Requisites.**—Forceps—dissecting, dressing, artery, compression (as Péan's, &c.)—aneurism needle, director, retractors and blunt hooks, scissors, needles, silk, catgut, drainage tubes, sponges, syringe, lotions, dressings, bandages, safety-pins, mackintosh, razor to shave with.

III. *Amputations.*—Tourniquets; amputating knives—these, if to be used for *transfixion*, should be half as long again as the diameter of the limb to be removed; saws, bone- and lion-forceps, splints; also I. and II.

IV. *Excisions.*—Tourniquets, strong bistouries, periosteum detachers, butcher and ordinary saws; bone-, lion-, and necrosis-forceps; gouge, sharp spoon, splints; also I. and II.

V. *Necrosis.*—Tourniquets, probe, bistouries, periosteum detacher, gouge, mallet and chisel, bone- and necrosis-forceps, splints; also I. and II.

VI. *Trephining.*—Bistouries, periosteum detacher, trephines, Hey's saw, elevators, bone-forceps, fine aspirator needle, tooth-picks; I. and II.

VII. *Operations on Jaws and Excision of Tongue.*—Tooth forceps, mouth gag, bistouries, metacarpal saw, bone-forceps, lion-forceps, strong scissors, vulsellum [bradawl and wire]; small sponges, firmly secured to holders, or tied on sticks, are required, and if a preliminary tracheotomy be employed, or a tube passed into the larynx, the suitable instruments must also be provided; I. and II.

VIII. *Tracheotomy* (see page 86).

IX. *Excision of Breast, Ligature of Vessel, Hernia, and Operations on Rectum and Anus.*—Bistouries, and I. and II.

X. *Operations on Urethra.*—Warm boracic lotion, and syphon or syringe; catheters, silver and gum-elastic; grooved staff, grooved probe, Syme's staff, instruments for internal urethrotomy, bistouries, gum-elastic catheter; carbolic oil, 1·20; I. and II.

XI. *Operation for Stone.*—Warm boracic lotion, and syphon or syringe; sound, catheters.

Crushing.—Bougies for dilating urethra, tenotomy knife, lithotrites, set of evacuators and washer out, extra pillow for pelvis.

Cutting.—Lithotomy knives and sounds, bistouries, lithotomy-forceps and scoop, Petersen's rectal tampon, blunt hooks and retractors, lithotomy tube; also I. and II.

XII. *Operations involving the Peritoneal Cavity and Colotomy.*—Makin's intestinal clamps. Where a cyst has to be removed, an aspirator or ovariotomy trocar must be in readiness; also numerous large cyst and pressure-forceps, and pedicle clamps. In every case, the instruments and sponges are to be carefully counted before and after operation. The lotions should be heated, and the sponges and towels also wrung out of warm lotion. A long mounted needle is often useful in dealing with renal and biliary calculi; also I. and II.

C. Various Practical Hints and Suggestions.

Extraction of Teeth.—The two chief points requiring attention in the extraction of teeth are (1) to get a firm hold of a strong part of the tooth as far up the fang as possible; (2) to loosen the tooth before trying to draw it out.

(1) Since many teeth which require extraction have their crowns more or less softened with decay, the need of taking a firm deep hold will be all the more apparent. The forceps must first be fitted accurately round the neck of the tooth, but not tight enough to hold it; they must then be pushed firmly, and often heavily, between the tooth and its surrounding gum and alveolus before the grasp is tightened. In the *upper jaw*, while the patient leans well back with the mouth open, the operator can easily press his forceps upwards. In the *lower jaw*, however, a different manœuvre is necessary. After the forceps, held in the operator's right hand, have been fitted on to the neck of the tooth, the operator presses them down with the thumb of his left hand placed upon them within the mouth, while the rest of the fingers of this hand are outside the mouth and grasp the lower jaw from below.

(2) As soon as the operator has, in either of these ways, taken a firm grasp of the tooth, he begins to rock it in its socket, pressing always more forcibly outwards, towards the cheek, than inwards. When, by this lateral movement, the tooth has been "started" from its socket, a drawing movement must be added, and, by a combination of the two, the tooth will be extracted. The outward pressure is more effectual than inward pressure would be, partly because the outer wall of the sockets is much thinner than the inner wall, and hence more easily yields, and partly because the fangs of the teeth are broader externally than internally, and hence would resist pressure inwards more effectually than pressure outwards.

Instruments Required (according to J. Smith).*—"Five pairs of

* Notes on Dental Surgery, by J. Smith, M.D., LL.D., &c., 1887: Maclachlan & Stewart, Edinburgh.

forceps will be found serviceable for most purposes, and fewer will not. These are a straight pair, and a pair with the blades nearly at right angles with the handles, both of which will be required for upper and lower roots, and single-fanged teeth; a pair adapted for the lower molars, and two pairs for the upper molars—one for the right and one for the left sides. Many other forms would be desirable, and may be collected, but these five pairs will be found absolutely necessary. It has been stated that the blades at their extremities should fit that part of the tooth they are intended to grasp. In this way it will be seen that for single-fanged teeth these blades will merely require to be adapted for the oval form presented by a transverse section of such fangs—hollowed out, in fact, so as to apply themselves more closely to their surface. For multiple-fanged teeth, the forceps must also be on the same principle, adapted to the form of the surface to which they are to be applied. One pair will be found to answer for the double-fanged molars of the lower jaw; but for the three-fanged molars of the upper jaw, two pairs will be necessary, as these three fangs are always so placed that two of them are next the cheek and one towards the palate; consequently, the forceps which would fit one side will not at all fit the other. With this number of forceps, properly constructed, almost any case of extraction may be undertaken where forceps can be used at all."

How to give a Hypodermic Injection.—To avoid the risk of mistake, the amount of the drug injected should always be calculated rather than the number of minims of solution. This is necessary, because the same drug is often prescribed for subcutaneous injection in solutions of different strengths.

Having determined the quantity of fluid to be injected, the operator either leaves only that amount in the syringe, or, having filled the syringe, adjusts the screw on the piston, when that special form of instrument is used. Next, he raises the needle end of the syringe, taps it to cause air-bells to rise, and gently expels them. Then, with the left forefinger and thumb, he pinches up a fold of skin, and, after dipping the needle into carbolised oil, boldly plunges it through to the loose subcutaneous tissue, into which he slowly and steadily drives the fluid. Finally, laying his left forefinger over the point of entrance, he withdraws the needle, and gently rubs the injected fluid into the surrounding tissue.

Before use, an antiseptic lotion should be run through the syringe and needle.

After use, the syringe and needle should be washed out with warm water, and the needle emptied by blowing through it. Then the wire should be inserted into its interior.

One or other of two forms of syringe are used—one where the number of minims is marked on the glass barrel of the syringe, the other where an adjustable screw is fitted to the piston rod, so that it may be brought to a stop at any desired point. The measurement markings are in this case made on the piston rod, so that by adjusting the screw any given portion of the fluid may be injected from a full syringe.

How to give an Enema.—Enemata or clysters are used for many purposes:—

(1) *For Clearing out the Rectum.*—For this purpose a large amount of fluid, a pint or more, is required, of warm water, either plain or made more stimulating by the addition of soap-suds, common salt (2 table

spoonfuls per pint), castor oil (½ to 1 oz.), turpentine (1 oz.), sulphate of magnesia (1 oz.). Glycerine in small quantity also acts most rapidly and efficiently, and may be employed as an enema (1–2 drachms injected with a small syringe), or as a suppository either of strong glycerine jelly or saturated on a plug of cotton wool about the size of a filbert nut.

(2) *For Cleansing the Mucous Membrane*, when it is ulcerated or diseased.—Six or eight ounces of warm fluid are sufficient. It should be charged with boracic acid, Condy's fluid, chlorate of potash, or any weak antiseptic. The possibility of some absorption should be borne in mind, although the greater part of the enema will be returned. When it is desired to wash out the rectum, the syphon principle is best (see p. 229).

(3) *For Nourishing the Patient.*—When the stomach cannot retain food or drink, or where complete rest to the alimentary canal is required, the absorptive power of the rectum must be utilised. As the rectal mucous membrane cannot digest, all nutrient enemata should be predigested. Moreover, to ensure retention, the amount at each injection should not exceed 2 ounces. When this form of alimentation is continued for long, the rectum should be cleaned out every second or third day by a large enema of hot water (see also p. 10).

When, with intense sickness, great thirst is complained of, frequent 2 ozs. enemata of warm water will give much relief.

(4) *For Stopping Diarrhœa.*—An enema of 6 ozs. of starch, in which ½ drm. of tinctura opii is suspended, will sometimes be successful when the mucous membrane of the lower end of the bowel is involved.

In Receiving an Enema, the patient should recline on the left side with a towel or mackintosh below him to catch any drippings. As Symington has pointed out, the lowest portion of the rectum is always firmly closed by the immediate contact of its walls. For from half to three-quarters of an inch, therefore, the injection nozzle, preceded by a well-oiled finger, must be firmly and steadily pushed upwards and slightly forwards, until it gets through this elongated barrier. It is then to be directed somewhat backwards. After it has got through the outer barrier, the nozzle can be retained with ease; but short of this, it will be ejected at once. The same applies to the introduction of suppositories. Some patients prefer to introduce the enema nozzle themselves.

The form of instrument most frequently used is a Higginson's syringe. With this, by working a ball, a continuous stream can be produced in one direction.

A syphon, or funnel with tube attached, would, however, serve the purpose equally well, and be much simpler (p. 229).

As soon as the nozzle is in position, the fluid must be slowly and steadily pumped in, or allowed to flow in.

How to make Poultices.—Poultices are now much less used than they were. When required, the material chiefly used in hospitals for making them is linseed meal; but oatmeal, starch, bread, bran, &c., may also be employed. Care must be taken in making poultices that they should turn out neither too dry nor too moist.

(1) *To make a Poultice of Linseed.*—Have a kettle of water boiling, linseed meal, two kitchen bowls (1 large, 1 small), a spatula, old linen, 1 or 2 heated plates.

First put some boiling water into the larger basin, into this basin

place the smaller one, which must have previously been heated by allowing boiling-water to stand in it for a minute or two. Put the linseed meal required into the smaller basin, pour in boiling-water gradually, and beat with the spatula into a thick paste.

Now take one of the heated plates, lay out on it the linen in which the poultice is to be placed, and spread over it quickly with the spatula the mixture from the basin. Dip the spatula into the larger basin of boiling water, otherwise the mixture will stick to it, and not spread freely on the linen. The poultice should be about ½-inch thick all over, and a margin of about 1½ inch should be left all round the linen to turn up over the edge of the poultice.

If the poultice has to be carried some distance to the patient, it should be placed between two heated plates.

The poultice should be gently applied, and, in the event of there being much discharge from the wound, it will be found an advantage to lay some absorbent cotton wool round it; over the poultice a piece of waterproof material; and then cotton wool or flannel should be placed to prevent evaporation and to retain the heat better. The poultice should be fixed in its place by a bandage or handkerchief.

Poultices should be applied as hot as the patient can bear them, without any material between the sore and the mixture, otherwise their value is diminished. They should be changed at least every three hours. It is hardly necessary to add that the poultice should at once be burned after removal.

(2) *Oatmeal Poultices* are made in the same way as linseed, but some authorities recommend that the meal should be previously boiled.

(3) *Starch Poultices.*—The starch should be first made into a stiff paste with cold water, and then mixed with boiling water to make it hot before being applied.

(4) *Bread Poultices.*—Boil some stale bread with water for five minutes. Drain off the water, and spread the bread on a piece of linen. A few drops of warm oil should be placed on the poultice, and so prevent it from sticking to the patient.

(5) *Bran Poultices* are made by pouring boiling water on to the required quantity of bran, and stirring well.

Antiseptic Precautions.—To any of the above poultices there may be added powdered charcoal, powdered boracic acid, or iodoform, to diminish fœtor and fermentation. The material should also be freely dusted over the surface of the sore, before the poultice is applied.

(6) *Mustard Poultice.*—When mustard leaves are not available, a mustard poultice can be made either by spreading mustard, prepared as if for use at table, on linen, or by simply shaking dry mustard over a linseed poultice, and then applying it to the patient.

How to Cleanse and Purify Sponges.—Sponges, when new, are to be repeatedly washed out of hot water, dried, and beaten until the sand is shaken out. Some recommend that they should then be steeped in an 8 per cent. solution of hydrochloric acid, until all calcareous particles are dissolved. They are then to be stored in 1–20 carbolic acid, and kept ready for use.

After having been used at Operations for some time.—(1) Free them from grease by steeping in a concentrated solution of washing soda.

(2) Then soak for twenty-four hours in permanganate of potash 1 gr. to 1 oz., and wash again in clean water.

(3) Soak in 1 per cent. solution of commercial salt of sub-sulphite of

soda, with 8 per cent. pure concentrated hydrochloric acid (in 24 ozs. of water, ℥i of the soda, and ℥ij of the acid) until (in about a quarter of an hour) they have become white.

(4) Again wash in water until scentless, and store in 5 per cent. carbolic acid. (In ordinary cases, after operations, the second and third directions may be omitted.)

When sponges are full of fibrin, Lister allows them to steep in water until the fibrin has decomposed, after which they are to be washed and steeped in carbolic as usual.

During an operation sponges should be squeezed dry of blood, and wrung out of 1–40 carbolic or 1 2000 corrosive sublimate lotion.

In all cases where *putrid discharges* have to be soaked up, masses of **absorbent wool** should be used instead of sponges.

How to Fill a Water-bed.—This should be done after it has been laid on the bed. The water must be warm, and should only about half fill the water-bed.

D. Various Formulæ (for Lotions, Caustics, &c.)

Urethral Injections.—(*a.*) *Antiseptic.*—Sulpho-carbolate of zinc, 2 grs. to 1 oz.; corrosive sublimate, ⅛ gr. to 1 oz. (nearly 1–4000); chloride of zinc, ¼ to 1 gr. to the 1 oz.; boracic acid, saturated.

(*b.*) *Astringent.*—Acetate of lead, 1 to 2 grs. to 1 oz.; sulphate of zinc, 2 grs. to 1 oz.; nitrate of silver, ¼ gr. to 1 oz.; alum, 5 grs. to 1 oz.

Evaporating Lotion.—℞. Ammoniæ chloridi, ℥i; spirit rect., ℥i; water, ℥x. To this ℥i of dilute acetic acid may be added.

Caustics.—(1) *Vienna Paste.*—Caustic potash, 5 drms.; slaked lime, 6 drms.; rectified spirit sufficient to make a mass. Spread on the part to be cauterised, and allow it to remain for 10 or 15 minutes. Surrounding skin protected by adhesive plaster (*Squire*). (For epithelial surfaces.)

(2) *Sulphuric Acid.*—Made into a paste with charcoal or sawdust applied to the desired place for 8 to 10 hours in a guttapercha tube softened and fitted close. (For sloughy and hæmorrhagic tumours.)

(3) *Bougard's Paste.*—Mix in a glass or china mortar, wheat flour, 60 grms.; powdered starch, 60 grms.; powdered arsenic, 1 grm.; cinnabar, 5 grms.; sal. ammoniac, 5 grms.; corrosive sublimate, 0·50 grms.; add slowly solution of chloride of zinc at 52° (C.), 245 grms., stirring well. In a covered jar this may be kept for months.

(4) *Chloride of Zinc*, deliquesced and made into a paste, with equal parts of flour, may be applied directly, or in lint or gauze, and kept on from 3 to 24 hours.

(5) *Lund's Styptic Discs.*—Steep blotting-paper in alcoholic solution of tannic acid—45 grs. to absolute alcohol 1 drm.; dry, and cut into small pieces for application to bleeding points.

(6) *Lund's Application for Strumous Glands.*—Potass. iod., ℥iv; amm. bromid, ℥ij; glycerini, ℥i; aq. rosæ, ℥i. Mix and add sp. vin. rect. q.s., ad. ℥iv. Paint on "many times during 24 hours."

Antiseptic Ligatures.—Catgut is made from the intestine of the sheep by scraping away the mucous membrane, and the peritoneal and muscular coats, thus leaving only the delicate *sub-mucous connective tissue.*

This is twisted and dried, as a whole, or in strips according to the thickness required.

(*a.*) **Lister's Chromic Acid Catgut.**—Pure carbolic acid (absolute phenol), 1 part dissolved in 20 parts of a solution of chromic acid in water (1 in 4,000).

As soon as the solution has been made, introduce into it catgut equal in weight to the phenol used. Steep for forty-eight hours; take out the catgut and dry it *on the stretch*. When dry, steep it in 1–5 carbolic oil, and it is ready for use.

(*b.*) **Macewen's Chromic Catgut.**—Make a watery solution of chromic acid, 1 to 5. Add 1 of this to 20 of glycerine. Hanks of catgut are steeped in this for seven or eight months—*i.e.*, until they become dark and semi-translucent. They are then ready for use, and are stored in carbolic (1–10) glycerine; this resists action of tissues for fourteen days, and is absorbed in twenty days.

(*c.*) *Later Method.*—Make A solution of chromic acid in water (1 in 5).

B ,, A in glycerine (1 in 5).

C ,, carbolic acid in glycerine (1 in 5).

Soak gut in B for four days; dry, then store it in C. This lasts for about a week in the tissues.

If gut were steeped in B for two days it would last four or five days, and be useful for sutures.

Macewen's Chicken-bone Drainage-tubes.—The tibia and femora of a chicken (after having been cooked) are scraped and steeped in hydrochloric acid and water (1–5) until soft. The articular ends having then been snipped off, the endosteum is raised at one end, and pushed through to the other along with its contents. They are next re-introduced into a fresh hydrochloric acid solution (1–5), till they become somewhat softer and more pliable than finally required. Lastly, they are steeped in carbolic acid and glycerine (1–10) for a fortnight, when they are ready for use. Holes may be punched or clipped. Duration in the tissues, about eight days.

If steeped in a chromicised instead of a carbolised solution, they will last from fourteen to twenty-one days.

Watson Cheyne's Antiseptic Bougies.—Iodoform, 5 grs.; oil of eucalyptus, 10 min.; oil of theobroma, 35 grs., in each bougie, which should be 4 inches long and diameter of No. 10 catheter.

Thomas' Pitch Pine Sawdust as a Surgical Dressing.—The following is the author's description of the mode of preparation and application:—"The formula of drugs with which I medicated the sawdust during many years was the following:—Ol eucalyptol, ʒiv; crude carbolic acid, ʒiv; aquæ, 4 gals. This mixture was used to gradually and carefully impregnate a quarter of a sackful of clean deal sawdust, the sawdust having been previously coarsely sieved, so as to remove any wood chippings. Having employed this mixture for many years, I have great confidence in it; but as it is a remedy that has been used very liberally, I have been anxious to cheapen it without decreasing its efficacy as a wound dressing. The formula I now employ is as follows:—Crude pyroligneous acid, 1 gal.; bichloride of mercury, 30 grs.; aquæ, 2 gals. This solution I employ to charge a quarter of a sackful of sawdust. This formula I have used now for several months, and so far it appears to me to be of equal efficiency to my former preparation. The pyroligneous acid

can be got in a crude state from the tar distillers, by gentlemen who prefer to make the preparation themselves. Those who may prefer it ready prepared can get it from Mr. Critchley, 88 Upper Pitt Street, Liverpool. Now as to the various modes of application. When I desire its action as a moist application, I cover the locality, or bury a portion of the limb in the prepared sawdust, immediately covering the sawdust with either guttapercha tissue or sheets of tinfoil. If I am using it for compound injury to the hand or wrist, a bare sheet-iron splint is applied and strapped to the part for the purpose of fixation, and the whole is then covered with an ample quantity of the dust, sustained by a cloth and bandages. When using it for a compound fracture of the forearm, two hollow sheet-iron splints of suitable length are selected; their concavities are well filled up with sawdust, and applied so as to protect the wound, as well as to fix the fracture. Should two splints not sufficiently cover them, a third of a similar pattern is added. The same plan is followed with compound fractures of the humerus. The reader will note that in using the sawdust to injuries of the hand, the support is applied primarily, the dust after. I follow the same rule with compound injuries of the ankle and foot; the means of fixation, if practicable, is first applied, then the dust. Occasionally, of course, this is not possible, and the order has to be reversed. In compound fractures of the leg I select an iron trough boot, which I half fill with sawdust and place the limb on the bed of dust, then reduce the deformity; fill up the trough as high as possible with dust, then apply my bare sheet-iron splints, lining them with the dust contained in the trough. For compound injuries of the knee-joint, and fractures of the thigh, I apply my ring splint, with its special mode of fixed extension, then bury the limb in the dust, which is sustained by a bedroom towel and a few bandages."

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